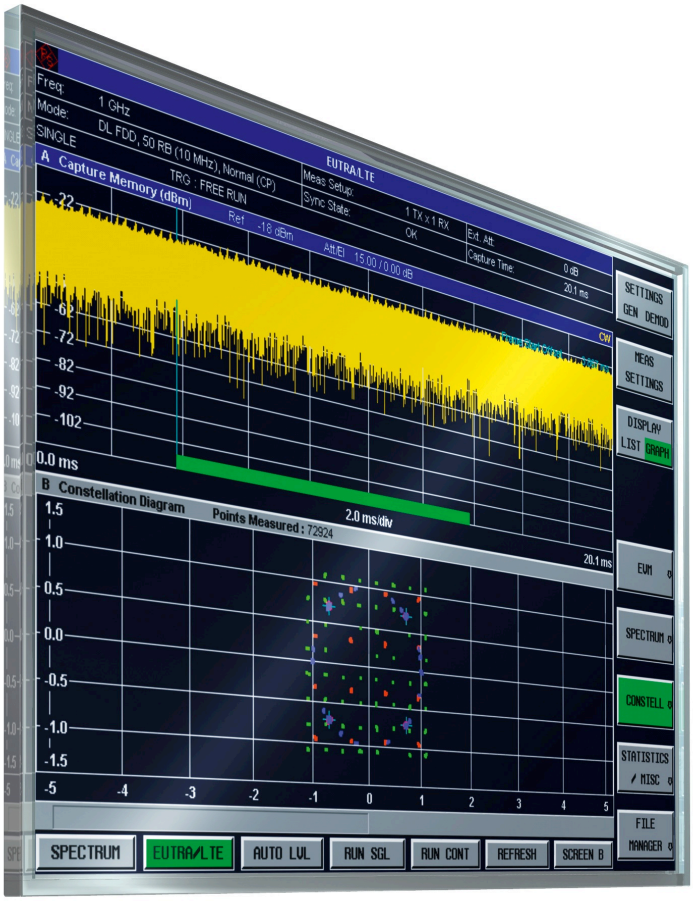
R&S®FSQ-K10x (LTE Downlink)
LTE Downlink Measurement Application
User Manual



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Test & Measurement

User Manual

ROHDE&SCHWARZ

This manual describes the following firmware applications:

- R&S®FSQ-K100 EUTRA / LTE FDD Downlink Measurement Application (1308.9006.02)
- R&S®FSQ-K102 EUTRA / LTE MIMO Downlink Measurement Application (1309.9000.02)
- R&S®FSQ-K104 EUTRA / LTE TDD Downlink Measurement Application (1309.9422.02)

This manual is applicable for the following R&S analyzer models with firmware 4.7x SP4 and higher:

- R&S®FSQ3 (1307.9002K03)
- R&S®FSQ8 (1307.9002K07)
- R&S®FSQ26 (1307.9002K13)
- R&S®FSQ40 (1307.9002K30)
- R&S®FSG8 (1309.0002.08)
- R&S®FSG13 (1309.0002.13)

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The following abbreviations are used throughout this manual: R&S®FSQ is abbreviated as R&S FSQ.

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1 Preface

1.1 Documentation Overview

The user documentation for the R&S FSQ consists of the following parts:

- "Getting Started" printed manual
- Documentation CD-ROM with:
  - Getting Started
  - User Manuals for base unit and options
  - Service Manual
  - Release Notes
  - Data sheet and product brochures

Getting Started

This manual is delivered with the instrument in printed form and in PDF format on the CD. It provides the information needed to set up and start working with the instrument. Basic operations and handling are described. Safety information is also included.

User Manuals

User manuals are provided for the base unit and each additional (software) option.

The user manuals are available in PDF format - in printable form - on the Documentation CD-ROM delivered with the instrument. In the user manuals, all instrument functions are described in detail. Furthermore, they provide a complete description of the remote control commands with programming examples.

The user manual for the base unit provides basic information on operating the R&S FSQ in general, and the Spectrum mode in particular. Furthermore, the software options that enhance the basic functionality for various measurement modes are described here. An introduction to remote control is provided, as well as information on maintenance, instrument interfaces and troubleshooting.

In the individual option manuals, the specific instrument functions of the option are described in detail. For additional information on default settings and parameters, refer to the data sheets. Basic information on operating the R&S FSQ is not included in the option manuals.

Service Manual

This manual is available in PDF format on the CD delivered with the instrument. It describes how to check compliance with rated specifications, instrument function, repair, troubleshooting and fault elimination. It contains all information required for repairing the R&S FSQ by replacing modules.

Release Notes

The release notes describe the installation of the firmware, new and modified functions, eliminated problems, and last minute changes to the documentation. The corresponding firmware version is indicated on the title page of the release notes. The most recent release notes are provided in the Internet.

1.2 Typographical Conventions

The following text markers are used throughout this documentation:

Convention	Description
"Graphical user interface elements"	All names of graphical user interface elements on the screen, such as dialog boxes, menus, options, buttons, and softkeys are enclosed by quotation marks.
KEYS	Key names are written in capital letters.
`File names, commands, program code`	File names, commands, coding samples and screen output are distinguished by their font.
Input	Input to be entered by the user is displayed in italics.
Links	Links that you can click are displayed in blue font.
"References"	References to other parts of the documentation are enclosed by quotation marks.

2 Introduction

Currently, UMTS networks worldwide are being upgraded to high speed downlink packet access (HSDPA) in order to increase data rate and capacity for downlink packet data. In the next step, high speed uplink packet access (HSUPA) will boost uplink performance in UMTS networks. While HSDPA was introduced as a 3GPP Release 5 feature, HSUPA is an important feature of 3GPP Release 6. The combination of HSDPA and HSUPA is often referred to as HSPA.

However, even with the introduction of HSPA, the evolution of UMTS has not reached its end. HSPA+ will bring significant enhancements in 3GPP Release 7. The objective is to enhance the performance of HSPA-based radio networks in terms of spectrum efficiency, peak data rate and latency, and to exploit the full potential of WCDMAbased 5 MHz operation. Important features of HSPA+ are downlink multiple input multiple output (MIMO), higher order modulation for uplink and downlink, improvements of layer 2 protocols, and continuous packet connectivity.

In order to ensure the competitiveness of UMTS for the next 10 years and beyond, concepts for UMTS long term evolution (LTE) have been investigated. The objective is a high-data-rate, low-latency and packet-optimized radio access technology. Therefore, a study item was launched in 3GPP Release 7 on evolved UMTS terrestrial radio access (EUTRA) and evolved UMTS terrestrial radio access network (EUTRAN). LTE/EUTRA will then form part of 3GPP Release 8 core specifications.

This introduction focuses on LTE/EUTRA technology. In the following, the terms LTE or EUTRA are used interchangeably.

In the context of the LTE study item, 3GPP work first focused on the definition of requirements, e.g. targets for data rate, capacity, spectrum efficiency, and latency. Also commercial aspects such as costs for installing and operating the network were considered. Based on these requirements, technical concepts for the air interface transmission schemes and protocols were studied. Notably, LTE uses new multiple access schemes on the air interface: orthogonal frequency division multiple access (OFDMA) in downlink and single carrier frequency division multiple access (SC-FDMA) in uplink. Furthermore, MIMO antenna schemes form an essential part of LTE. In an attempt to simplify protocol architecture, LTE brings some major changes to the existing UMTS protocol concepts. Impact on the overall network architecture including the core network is being investigated in the context of 3GPP system architecture evolution (SAE).

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2.1 Requirements for UMTS Long-Term Evolution

LTE is focusing on optimum support of packet switched (PS) services. Main requirements for the design of an LTE system are documented in 3GPP TR 25.913 [1] and can be summarized as follows:

- Data Rate: Peak data rates target 100 Mbps (downlink) and 50 Mbps (uplink) for 20 MHz spectrum allocation, assuming two receive antennas and one transmit antenna are at the terminal.
- Throughput: The target for downlink average user throughput per MHz is three to four times better than Release 6. The target for uplink average user throughput per MHz is two to three times better than Release 6.
- Spectrum efficiency: The downlink target is three to four times better than Release 6. The uplink target is two to three times better than Release 6.
- Latency: The one-way transit time between a packet being available at the IP layer in either the UE or radio access network and the availability of this packet at IP layer in the radio access network/UE shall be less than 5 ms. Also C-plane latency shall be reduced, e.g. to allow fast transition times of less than 100 ms from camped state to active state.
- Bandwidth: Scaleable bandwidths of 5 MHz, 10 MHz, 15 MHz, and 20 MHz shall be supported. Also bandwidths smaller than 5 MHz shall be supported for more flexibility.
- Interworking: Interworking with existing UTRAN/GERAN systems and non-3GPP systems shall be ensured. Multimode terminals shall support handover to and from UTRAN and GERAN as well as inter-RAT measurements. Interruption time for handover between EUTRAN and UTRAN/GERAN shall be less than 300 ms for realtime services and less than 500 ms for non-realtime services.
- Multimedia broadcast multicast services (MBMS): MBMS shall be further enhanced and is then referred to as E-MBMS.
- Costs: Reduced CAPEX and OPEX including backhaul shall be achieved. Costeffective migration from Release 6 UTRA radio interface and architecture shall be possible. Reasonable system and terminal complexity, cost, and power consumption shall be ensured. All the interfaces specified shall be open for multivendor equipment interoperability.
- Mobility: The system should be optimized for low mobile speed (0 to 15 km/h), but higher mobile speeds shall be supported as well, including high speed train environment as a special case.
- Spectrum allocation: Operation in paired (frequency division duplex / FDD mode) and unpaired spectrum (time division duplex / TDD mode) is possible.
- Co-existence: Co-existence in the same geographical area and co-location with GERAN/UTRAN shall be ensured. Also, co-existence between operators in adjacent bands as well as cross-border co-existence is a requirement.
- Quality of Service: End-to-end quality of service (QoS) shall be supported. VoIP should be supported with at least as good radio and backhaul efficiency and latency as voice traffic over the UMTS circuit switched networks.
- Network synchronization: Time synchronization of different network sites shall not be mandated.

2.2 Long-Term Evolution Downlink Transmission Scheme

2.2.1 OFDMA

The downlink transmission scheme for EUTRA FDD and TDD modes is based on conventional OFDM.

In an OFDM system, the available spectrum is divided into multiple carriers, called subcarriers, which are orthogonal to each other. Each of these subcarriers is independently modulated by a low rate data stream.

OFDM is used as well in WLAN, WiMAX and broadcast technologies like DVB. OFDM has several benefits including its robustness against multipath fading and its efficient receiver architecture.

figure 2-1 shows a representation of an OFDM signal taken from 3GPP TR 25.892 [2]. In this figure, a signal with 5 MHz bandwidth is shown, but the principle is of course the same for the other EUTRA bandwidths. Data symbols are independently modulated and transmitted over a high number of closely spaced orthogonal subcarriers. In EUTRA, downlink modulation schemes QPSK, 16QAM, and 64QAM are available.

In the time domain, a guard interval may be added to each symbol to combat inter-OFDM-symbol-interference due to channel delay spread. In EUTRA, the guard interval is a cyclic prefix which is inserted prior to each OFDM symbol.

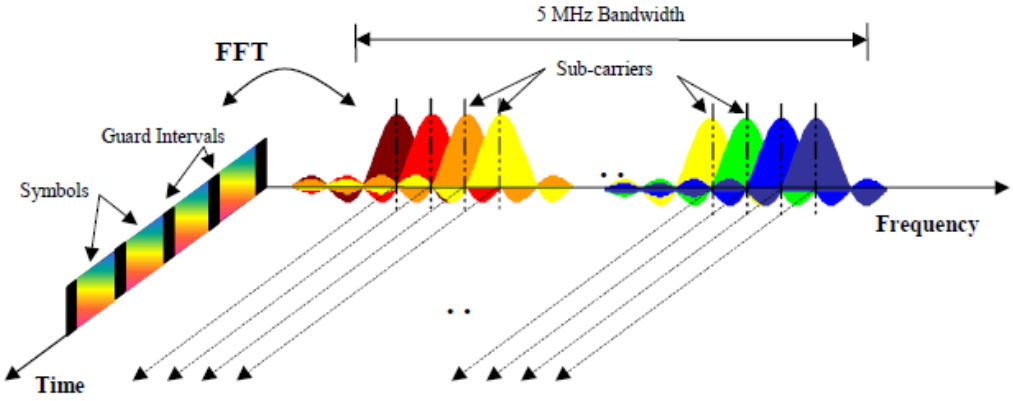

Fig. 2-1: Frequency-Time Representation of an OFDM Signal

In practice, the OFDM signal can be generated using the inverse fast Fourier transform (IFFT) digital signal processing. The IFFT converts a number N of complex data symbols used as frequency domain bins into the time domain signal. Such an N-point IFFT is illustrated in figure 2-2, where a(mN+n) refers to the n^{th} subchannel modulated data symbol, during the time period $mT_u < t \leq (m+1)T_u$.

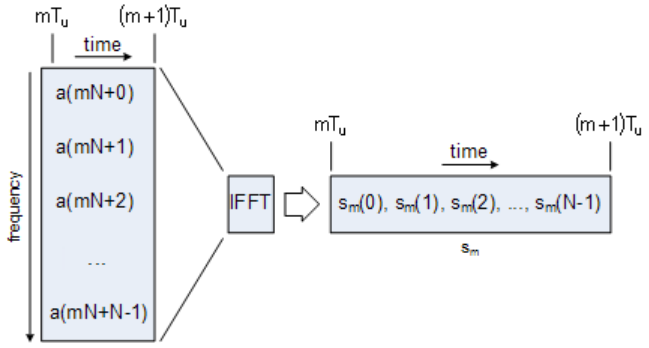

Fig. 2-2: OFDM useful symbol generation using an IFFT

The vector s_m is defined as the useful OFDM symbol. It is the time superposition of the N narrowband modulated subcarriers. Therefore, from a parallel stream of N sources of data, each one independently modulated, a waveform composed of N orthogonal subcarriers is obtained, with each subcarrier having the shape of a frequency sinc function (see figure 2-1).

figure 2-3 illustrates the mapping from a serial stream of QAM symbols to N parallel streams, used as frequency domain bins for the IFFT. The N-point time domain blocks obtained from the IFFT are then serialized to create a time domain signal. Not shown in figure 2-3 is the process of cyclic prefix insertion.

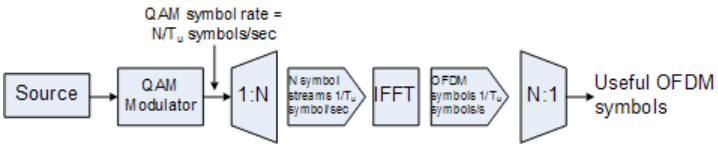

Fig. 2-3: OFDM Signal Generation Chain

In contrast to an OFDM transmission scheme, OFDMA allows the access of multiple users on the available bandwidth. Each user is assigned a specific time-frequency resource. As a fundamental principle of EUTRA, the data channels are shared channels, i.e. for each transmission time interval of 1 ms, a new scheduling decision is taken regarding which users are assigned to which time/frequency resources during this transmission time interval.

2.2.2 OFDMA Parameterization

A generic frame structure is defined for both EUTRA FDD and TDD modes. Additionally, an alternative frame structure is defined for the TDD mode only. The EUTRA frame structures are defined in 3GPP TS 36.211. For the generic frame structure, the 10 ms radio frame is divided into 20 equally sized slots of 0.5 ms. A subframe consists of two consecutive slots, so one radio frame contains 10 subframes. This is illustrated in figure 2-4 (T_s expresses the basic time unit corresponding to 30.72 MHz).

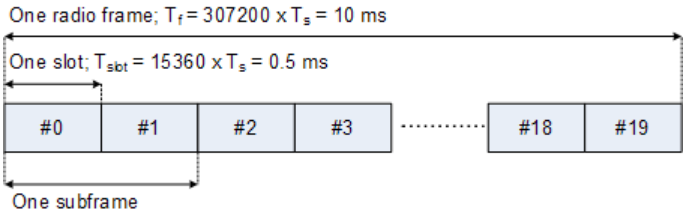

Fig. 2-4: Generic Frame Structure in EUTRA Downlink

figure 2-5shows the structure of the downlink resource grid for the duration of one downlink slot. The available downlink bandwidth consists of N_{BW}^{DL} subcarriers with a spacing of Δf = 15 kHz. In the case of multi-cell MBMS transmission, a subcarrier spacing of Δf = 7.5 kHz is also possible. N_{BW}^{DL} can vary in order to allow for scalable bandwidth operation up to 20 MHz. Initially, the bandwidths for LTE were explicitly defined within layer 1 specifications. Later on a bandwidth agnostic layer 1 was introduced, with N_{BW}^{DL} for the different bandwidths to be specified by 3GPP RAN4 to meet performance requirements, e.g. for out-of-band emission requirements and regulatory emission limits.

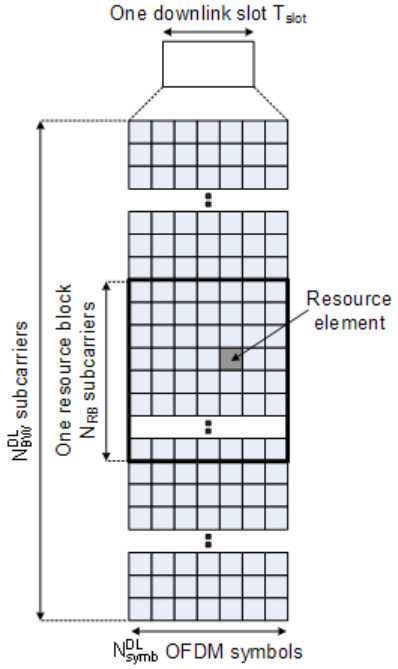

Fig. 2-5: Downlink Resource Grid

One downlink slot consists of N_{symb}^{DL} OFDM symbols. To each symbol, a cyclic prefix (CP) is appended as guard time, compare figure 2-1. N_{symb}^{DL} depends on the cyclic prefix length. The generic frame structure with normal cyclic prefix length contains N_{symb}^{DL} = 7 symbols. This translates into a cyclic prefix length of T_{CP}≈5.2µs for the first symbol and T_{CP}≈4.7µs for the remaining 6 symbols. Additionally, an extended cyclic prefix is defined in order to cover large cell scenarios with higher delay spread and MBMS transmission. The generic frame structure with extended cyclic prefix of $T_{CP\text{-}E}$≈16.7µs contains N_{symb}^{DL} = 6 OFDM symbols (subcarrier spacing 15 kHz). The generic frame structure with extended cyclic prefix

of T_{CP-E}≈33.3µs contains N_{symb}^{DL} = 3 symbols (subcarrier spacing 7.5 kHz). table 2-1 gives an overview of the different parameters for the generic frame structure.

Table 2-1: Parameters for Downlink Generic Frame Structure

Configuration	Number of Symbols N_{symb}^{DL}	Cyclic Prefix Length in Samples	Cyclic Prefix Length in µs
Normal cyclic prefix Δf=15 kHz	7	160 for first symbol 144 for other symbols	5.2 µs for first symbol 4.7 µs for other symbols
Extended cyclic prefix Δf=15 kHz	6	512	16.7 µs
Extended cyclic prefix Δf=7.5 kHz	3	1024	33.3 µs

2.2.3 Downlink Data Transmission

Data is allocated to the UEs in terms of resource blocks. A physical resource block consists of 12 (24) consecutive subcarriers in the frequency domain for the Δf=15 kHz (Δf=7.5 kHz) case. In the time domain, a physical resource block consists of DL N_{symb} consecutive OFDM symbols, see figure 2-5. N_{symb}^{DL} is equal to the number of OFDM symbols in a slot. The resource block size is the same for all bandwidths, therefore the number of available physical resource blocks depends on the bandwidth. Depending on the required data rate, each UE can be assigned one or more resource blocks in each transmission time interval of 1 ms. The scheduling decision is done in the base station (eNodeB). The user data is carried on the physical downlink shared channel (PDSCH). Downlink control signaling on the physical downlink control channel (PDCCH) is used to convey the scheduling decisions to individual UEs. The PDCCH is located in the first OFDM symbols of a slot.

2.2.4 Downlink Reference Signal Structure and Cell Search

The downlink reference signal structure is important for cell search, channel estimation and neighbor cell monitoring. figure 2-6 shows the principle of the downlink reference signal structure for one-antenna, two-antenna, and four-antenna transmission. Specific predefined resource elements in the time-frequency domain carry the reference signal sequence. Besides first reference symbols, there may be a need for second reference symbols. The different colors in figure 2-6 represent the sequences transmitted from up to four transmit antennas.

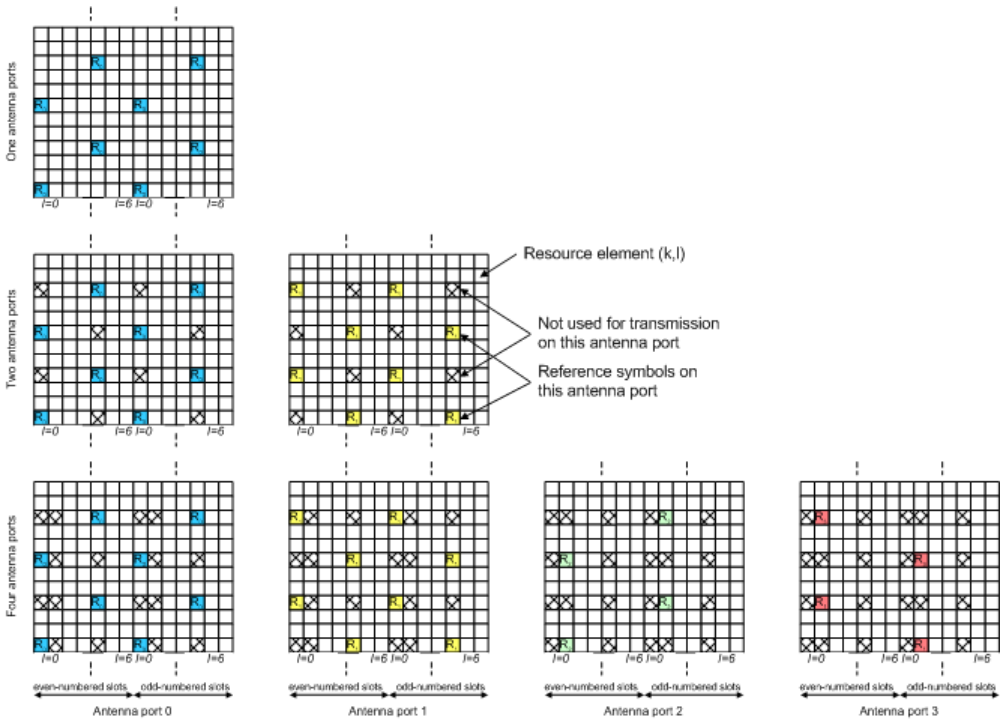

Fig. 2-6: Downlink Reference Signal Structure (Normal Cyclic Prefix)

The reference signal sequence carries the cell identity. Each reference signal sequence is generated as a symbol-by-symbol product of an orthogonal sequence r^{OS} (three of them existing) and a pseudo-random sequence r^{PRS} (170 of them existing). Each cell identity corresponds to a unique combination of one orthogonal sequence r^{OS} and one pseudo-random sequence r^{PRS}, allowing 510 different cell identities.

Frequency hopping can be applied to the downlink reference signals. The frequency hopping pattern has a period of one frame (10 ms).

During cell search, different types of information need to be identified by the handset: symbol and radio frame timing, frequency, cell identification, overall transmission bandwidth, antenna configuration, and cyclic prefix length.

Besides the reference symbols, synchronization signals are therefore needed during cell search. EUTRA uses a hierarchical cell search scheme similar to WCDMA. This means that the synchronization acquisition and the cell group identifier are obtained from different synchronization signals. Thus, a primary synchronization signal (P-SYNC) and a secondary synchronization signal (S-SYNC) are assigned a predefined structure. They are transmitted on the 72 center subcarriers (around the DC subcarrier) within the same predefined slots (twice per 10 ms) on different resource elements, see figure 2-7.

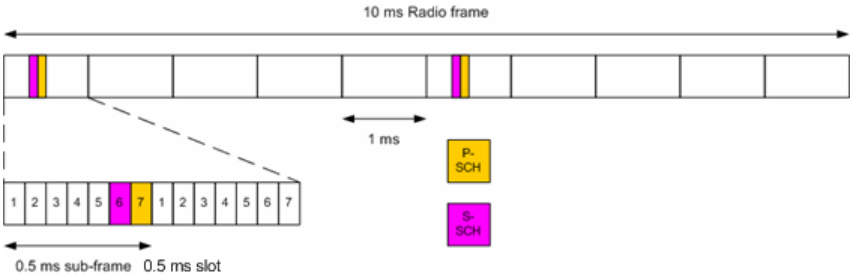

Fig. 2-7: P-SYNC and S-SYNC Structure

As additional help during cell search, a common control physical channel (CCPCH) is available which carries BCH type of information, e.g. system bandwidth. It is transmitted at predefined time instants on the 72 subcarriers centered around the DC subcarrier.

In order to enable the UE to support this cell search concept, it was agreed to have a minimum UE bandwidth reception capability of 20 MHz.

2.2.5 Downlink Physical Layer Procedures

For EUTRA, the following downlink physical layer procedures are especially important:

- **Cell search and synchronization**
  See above.
- **Scheduling**
  Scheduling is done in the base station (eNodeB). The downlink control channel PDCCH informs the users about their allocated time/frequency resources and the transmission formats to use. The scheduler evaluates different types of information, e.g. quality of service parameters, measurements from the UE, UE capabilities, and buffer status.
- **Link adaptation**
  Link adaptation is already known from HSDPA as adaptive modulation and coding. Also in EUTRA, modulation and coding for the shared data channel is not fixed, but rather is adapted according to radio link quality. For this purpose, the UE regularly reports channel quality indications (CQI) to the eNodeB.
- **Hybrid automatic repeat request (ARQ)**
  Downlink hybrid ARQ is also known from HSDPA. It is a retransmission protocol. The UE can request retransmissions of incorrectly received data packets.

2.3 References

[1] 3GPP TS 25.913: Requirements for E-UTRA and E-UTRAN (Release 7)

[2] 3GPP TR 25.892: Feasibility Study for Orthogonal Frequency Division Multiplexing (OFDM) for UTRAN enhancement (Release 6)

[3] 3GPP TS 36.211 v8.3.0: Physical Channels and Modulation (Release 8)

[4] 3GPP TS 36.300: E-UTRA and E-UTRAN; Overall Description; Stage 2 (Release 8)

[5] 3GPP TS 22.978: All-IP Network (AIPN) feasibility study (Release 7)

[6] 3GPP TS 25.213: Spreading and modulation (FDD)

[7] Speth, M., Fechtel, S., Fock, G., and Meyr, H.: Optimum Receiver Design for Wireless Broad-Band Systems Using OFDM – Part I. IEEE Trans. on Commun. Vol. 47 (1999) No. 11, pp. 1668-1677.

[8] Speth, M., Fechtel, S., Fock, G., and Meyr, H.: Optimum Receiver Design for OFDM-Based Broadband Transmission – Part II: A Case Study. IEEE Trans. on Commun. Vol. 49 (2001) No. 4, pp. 571-578.

3 Welcome

The EUTRA/LTE software application makes use of the I/Q capture functionality of the following spectrum and signal analyzers to enable EUTRA/LTE TX measurements conforming to the EUTRA specification.

- R&S FSQ
- R&S FSG

This manual contains all information necessary to configure, perform and analyze such measurements.

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3.1 Installing the Software

For information on the installation procedure see the release notes of the R&S FSQ.

3.2 Application Overview

Starting the application

Access the application via the "Mode" menu.

► Press the MODE key and select "LTE".
Note that you may have to browse through the "Mode" menu with the "Next" key to find the LTE entry.

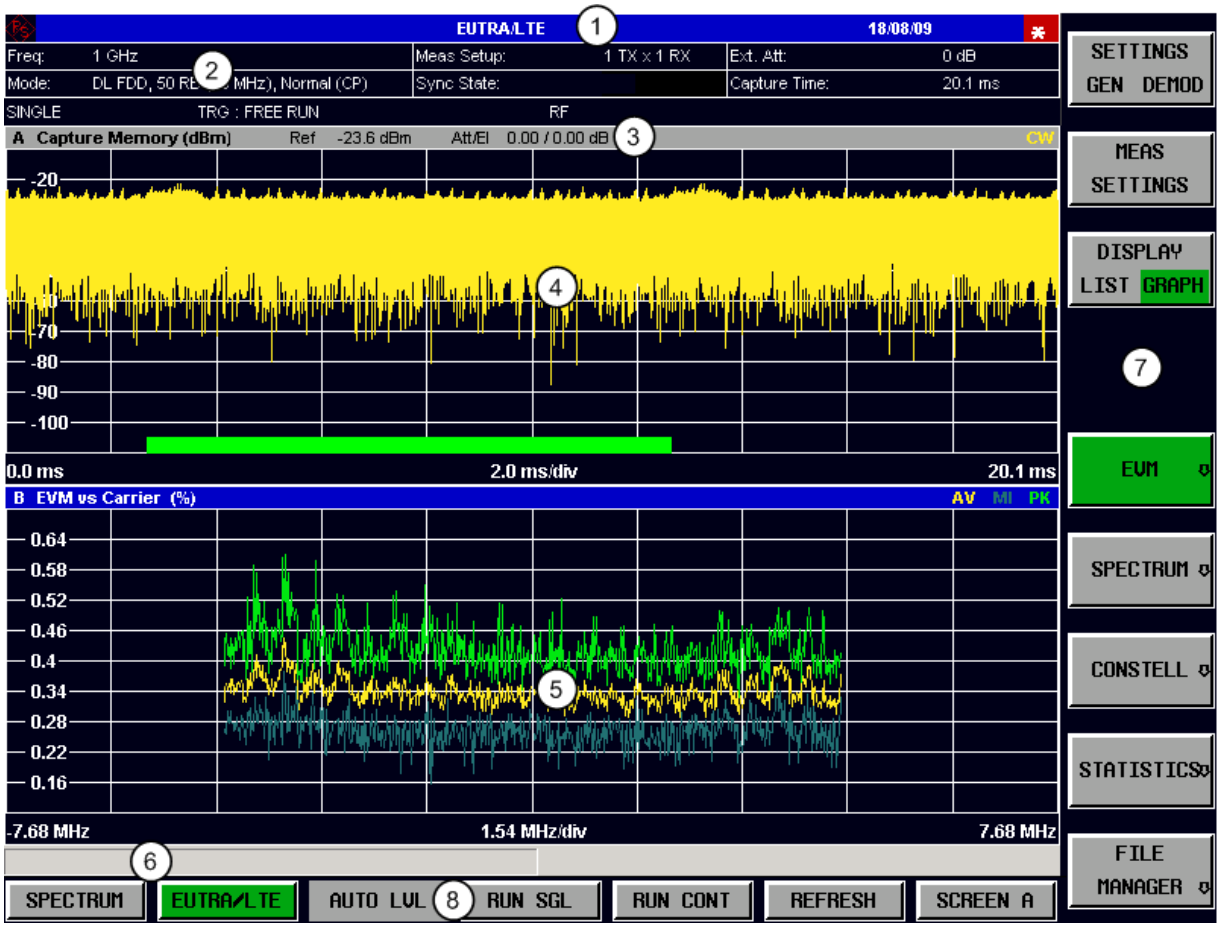
Presetting the software

When you first start the software, all settings are in their default state. After you have changed any parameter, you can restore the default state with the PRESET key.

`CONFigure:PRESet` on page 145

Elements and layout of the user interface

The user interface of the LTE measurement application is made up of several elements.



1 = Title Bar: shows the currently active measurement application
2 = Table Header: shows basic measurement information, e.g. the frequency
3 = Result Display Header: shows information about the display trace
4 = Result Display Screen A: shows the measurement results
5 = Result Display Screen B: shows the measurement results
6 = Status Bar: shows the measurement progress, software messages and errors
7 = Softkeys: open settings dialogs and select result displays
8 = Hotkeys: control the measurement process (e.g. running a measurement)

The status and title bar

The title bar at the very top of the screen shows the name of the application currently running.

The status bar is located at the bottom of the display. It shows the current measurement status and its progress in a running measurement. The status bar also shows warning and error messages. Error messages are generally highlighted.

Display of measurement settings

The header table above the result displays shows information on hardware and measurement settings.

The header table includes the following information

- **Freq**
  The analyzer RF frequency.
- **Mode**
  Link direction, duplexing, cyclic prefix and maximum number of physical resource blocks (PRBs) / signal bandwidth.
- **Meas Setup**
  Shows number of transmitting and receiving antennas.
- **Sync State**
  The following synchronization states may occur:
  – **OK** The synchronization was successful.
  – **FAIL (C)** The cyclic prefix correlation failed.
  – **FAIL (P)** The P-SYNC correlation failed.
  – **FAIL (S)** The S-SYNC correlation failed.

  Any combination of C, P and S may occur.
  SCPI Command:
  `[SENSe]:SYNC[:STATe]?` on page 95
- **Ext. Att**
  Shows the external attenuation in dB.
- **Capture Time**
  Shows the capture length in ms.

3.3 Support

If you encounter any problems when using the application, you can contact the Rohde & Schwarz support to get help for the problem.

To make the solution easier, use the "R&S Support" softkey to export useful information for troubleshooting. The R&S FSQ stores the information in a number of files that are located in the R&S FSQ directory `C:\R_S\Instr\user\LTE\Support`. If you contact Rohde & Schwarz to get help on a certain problem, send these files to the support in order to identify and solve the problem faster.

4 Measurement Basics

This chapter provides background information on the measurements and result displays available with the LTE Analysis Software.

- Symbols and Variables....21
- Overview....22
- The LTE Downlink Analysis Measurement Application....22
- Performing Time Alignment Measurements....25
- Performing Transmit On/Off Power Measurements....27

4.1 Symbols and Variables

The following chapters use various symbols and variables in the equations that the measurements are based on. The table below explains these symbols for a better understanding of the measurement principles.

$a_{l,k}\hat{a}_{l,k}$	data symbol (actual, decided)
$b_{l,k}$	boosting factor
Δf, $\Delta \hat{f}_{coarse}$	carrier frequency offset between transmitter and receiver (actual, coarse estimate)
Δf_{res}	residual carrier frequency offset
ζ	relative sampling frequency offset
$H_{l,k}$, $\hat{H}_{l,k}$	channel transfer function (actual, estimate)
i	time index
$\hat{i}_{coarse}$, $\hat{i}_{fine}$	timing estimate (coarse, fine)
k	subcarrier index
l	OFDM symbol index
N_{FFT}	length of FFT
N_g	number of samples in cyclic prefix (guard interval)
N_s	number of Nyquist samples
N_{RE}	number of resource elements
n	subchannel index, subframe index
$n_{l,k}$	noise sample
Φ_l	common phase error
r(i)	received sample in the time domain
$r_{l,k}$, $r'_{l,k}$, $r''_{l,k}$	received sample (uncompensated, partially compensated, equalized) in the frequency domain

T	useful symbol time
T_g	guard time
T_s	symbol time

4.2 Overview

The digital signal processing (DSP) involves several stages until the software can present results like the EVM.

The contents of this chapter are structered like the DSP.

4.3 The LTE Downlink Analysis Measurement Application

The block diagram in figure 4-1 shows the EUTRA/LTE downlink measurement application from the capture buffer containing the I/Q data to the actual analysis block. The outcome of the fully compensated reference path (green) are the estimates $\hat{a}_{l,k}$ of the transmitted data symbols $a_{l,k}$. Depending on the user-defined compensation, the received samples $r''_{l,k}$ of the measurement path (yellow) still contain the transmitted signal impairments of interest. The analysis block reveals these impairments by comparing the reference and the measurement path. Prior to the analysis, diverse synchronization and channel estimation tasks have to be accomplished.

4.3.1 Synchronization

The first of the synchronization tasks is to estimate the OFDM symbol timing, which coarsely estimates both timing and carrier frequency offset. The frame synchronization block determines the position of the P-/S-Sync symbols in time and frequency by using the coarse fractional frequency offset compensated capture buffer and the timing estimate $\hat{\imath}_{coarse}$ to position the window of the FFT. If no P-/S-Sync is available in the signal, the reference signal is used for synchronization. The fine timing block prior to the FFT allows a timing improvement and makes sure that the EVM window is centered on the measured cyclic prefix of the considered OFDM symbol. For the 3GPP EVM calculation according to 3GPP TS 36.211 (v8.9.0), the block “window” produces three signals taken at the timing offsets $\Delta\tilde{\imath}$, $\Delta\tilde{\imath}_l$ and $\Delta\tilde{\imath}_h$. For the reference path, only the signal taken at the timing offset $\Delta\tilde{\imath}$ is used.

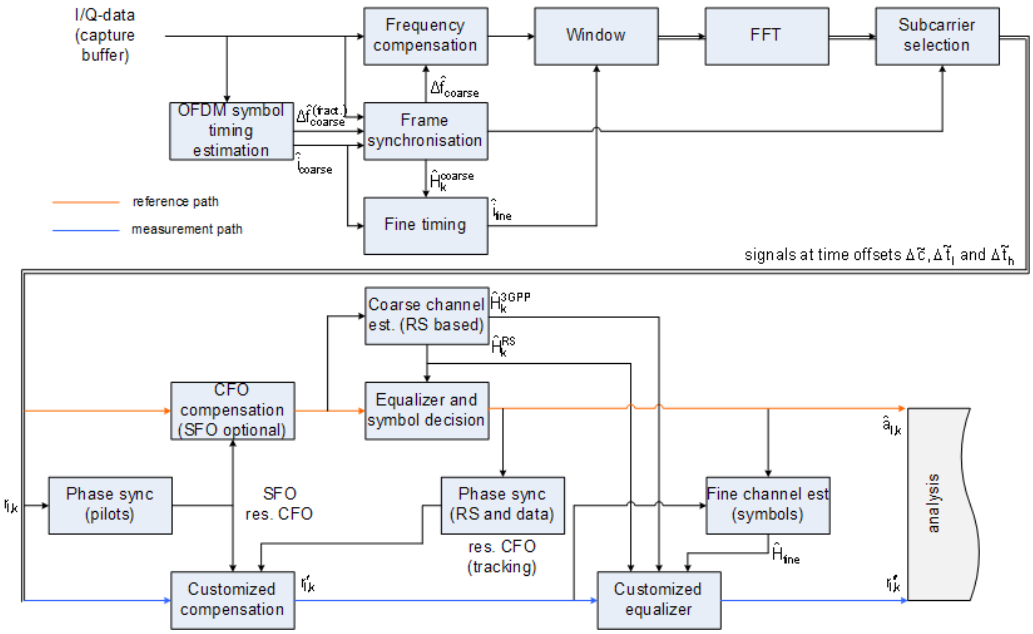


Fig. 4-1: Block diagram for the LTE DL measurement application

After the time to frequency transformation by an FFT of length N_{FFT}, the phase synchronization block is used to estimate the following:

- the relative sampling frequency offset ζ (SFO)
- the residual carrier frequency offset Δf_{res} (CFO)
- the common phase error Φ_l (CPE)

According to 3GPP TS 25.913 and 3GPP TR 25.892, the uncompensated samples can be expressed as

$$R_{l,k} = A_{l,k} \cdot H_{l,k} \cdot \underbrace{e^{j\Phi_l}}_{CPE} \cdot \underbrace{e^{j2\pi \cdot N_S / N_{FFT} \cdot \zeta \cdot k \cdot l}}_{SFO} \cdot \underbrace{e^{j2\pi \cdot N_S / N_{FFT} \cdot \Delta f_{res} \cdot T \cdot l}}_{res.CFO} + N_{l,k} \qquad (4 - 1)$$

where

- the data symbol is $a_{l,k}$, on subcarrier k at OFDM symbol l
- the channel transfer function is $h_{l,k}$
- the number of Nyquist samples is N_s within the symbol time T_s
- the useful symbol time $T=T_s-T_g$
- the independent and Gaussian distributed noise sample is $n_{l,k}$

Within one OFDM symbol, both the CPE and the residual CFO cause the same phase rotation for each subcarrier, while the rotation due to the SFO depends linearly on the subcarrier index. A linear phase increase in symbol direction can be observed for the residual CFO as well as for the SFO.

The results of the tracking estimation block are used to compensate the samples $r_{l,k}$

Whereas a full compensation is performed in the reference path, the signal impairments that are of interest to the user are left uncompensated in the measurement path.

After having decided the data symbols in the reference path, an additional phase tracking can be utilized to refine the CPE estimation.

4.3.2 Channel Estimation and Equalizitaion

As shown in figure 4-1, there is one coarse and one fine channel estimation block. The reference signal-based coarse estimation is tapped behind the CFO compensation block (SFO compensation can optionally be enabled) of the reference path. The coarse estimation block uses the reference signal symbols to determine estimates of the channel transfer function by interpolation in both time and frequency direction. A special channel estimation ($\hat{H}_k^{3GPP}$) as defined in 3GPP TS 36.211 is additionally generated. The coarse estimation results are used to equalize the samples of the reference path prior to symbol decision. Based on the decided data symbols, a fine channel estimation is optimally performed and then used to equalize the partially compensated samples of the measurement path.

4.3.3 Analysis

The analysis block of the EUTRA/LTE downlink measurement application allows to compute a variety of measurement variables.

EVM

The error vector magnitude (EVM) measurement results 'EVM PDSCH QPSK/16-QAM/ 64-QAM' are calculated according to the specification in 3GPP TS 36.211.

All other EVM measurement results are calculated according to

$$EVM_{l,k} = \frac{\left| r''_{l,k} - \hat{a}_{l,k} \right|}{b_{l,k} \sqrt{E\left\{ \left| \frac{a_{l,k}}{b_{l,k}} \right|^2 \right\}}} \qquad (4 - 2)$$

on subcarrier k at OFDM symbol l, where $b_{l,k}$ is the boosting factor. Since the average power of all possible constellations is 1 when no boosting is applied, the equation can be rewritten as

$$EVM_{n,l} = \frac{\left| r''_{l,k} - \hat{a}_{l,k} \right|}{b_{l,k}} \qquad (4 - 3)$$

The average EVM of all data subcarriers is then

$$EVM_{data} = \sqrt{\frac{1}{N_{REdata}} \sum_{l} \sum_{k_{data}} EVM_{l,k_{data}}^{2}}$$

(4 - 4)

The number of resource elements taken into account is denoted by $N_{RE\ data}$.

I/Q imbalance

The I/Q imbalance can be written as

$$r(t) = I\,\Re\{s(t)\} + jQ\,\Im\{s(t)\}$$

(4 - 5)

where s(t) is the transmit signal, r(t) is the received signal, and I and Q are the weighting factors. We define that I:=1 and Q:=1+ΔQ.

The I/Q imbalance estimation makes it possible to evaluate the

$$\text{modulator gain balance} = |1 + \Delta Q|$$

(4 - 6)

and the

$$\text{quadrature mismatch} = \arg\{1 + \Delta Q\}$$

(4 - 7)

based on the complex-valued estimate $\widehat{\Delta Q}$.

Other measurement variables

Without going into detail, the EUTRA/LTE downlink measurement application additionally provides the following results.

- Total power
- Constellation diagram
- Group delay
- I/Q offset
- Crest factor
- Spectral flatness

4.4 Performing Time Alignment Measurements

The MIMO measurement application provides the possibility to perform time alignment measurements between the different antennas for 2 or 4 TX antenna MIMO configurations. The time alignment error values represent the time offset between the considered antenna and antenna 1 and will be displayed in the result summary. A schematic description of the results is provided in figure 4-3.

A test setup for time alignment measurements is shown in figure 4-2. The dashed connections are only required for 4 TX antenna MIMO configuration. For best measurement result accuracy it is recommended to use cables of the same length and identical combiners as adders.

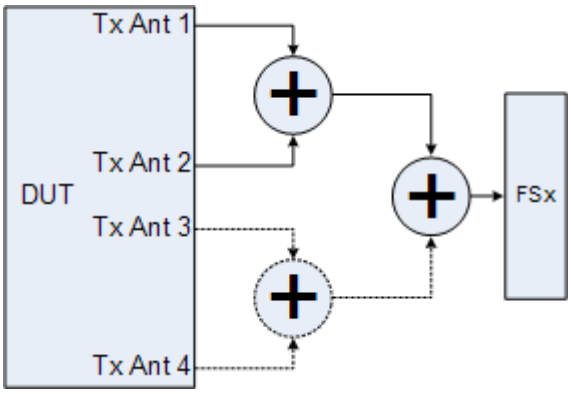


Fig. 4-2: Time alignment measurement hardware setup

For a successful time alignment measurement, make sure to set up the measurement correctly.

- the subframe selection in the general settings menu must be set to "All"
- enable "Compensate Crosstalk" in the demodulation settings, see screenshot below

Note that the time alignment measurement only uses the reference signal and therefore ignores any PDSCH settings (e.g. it does not have an influence on this measurement if the PDSCH MIMO scheme is set to transmit diversity or spatial multiplexing).

The EVM will usually be very high for this measurement. This does not effect the accuracy of the time alignment error measurement result.

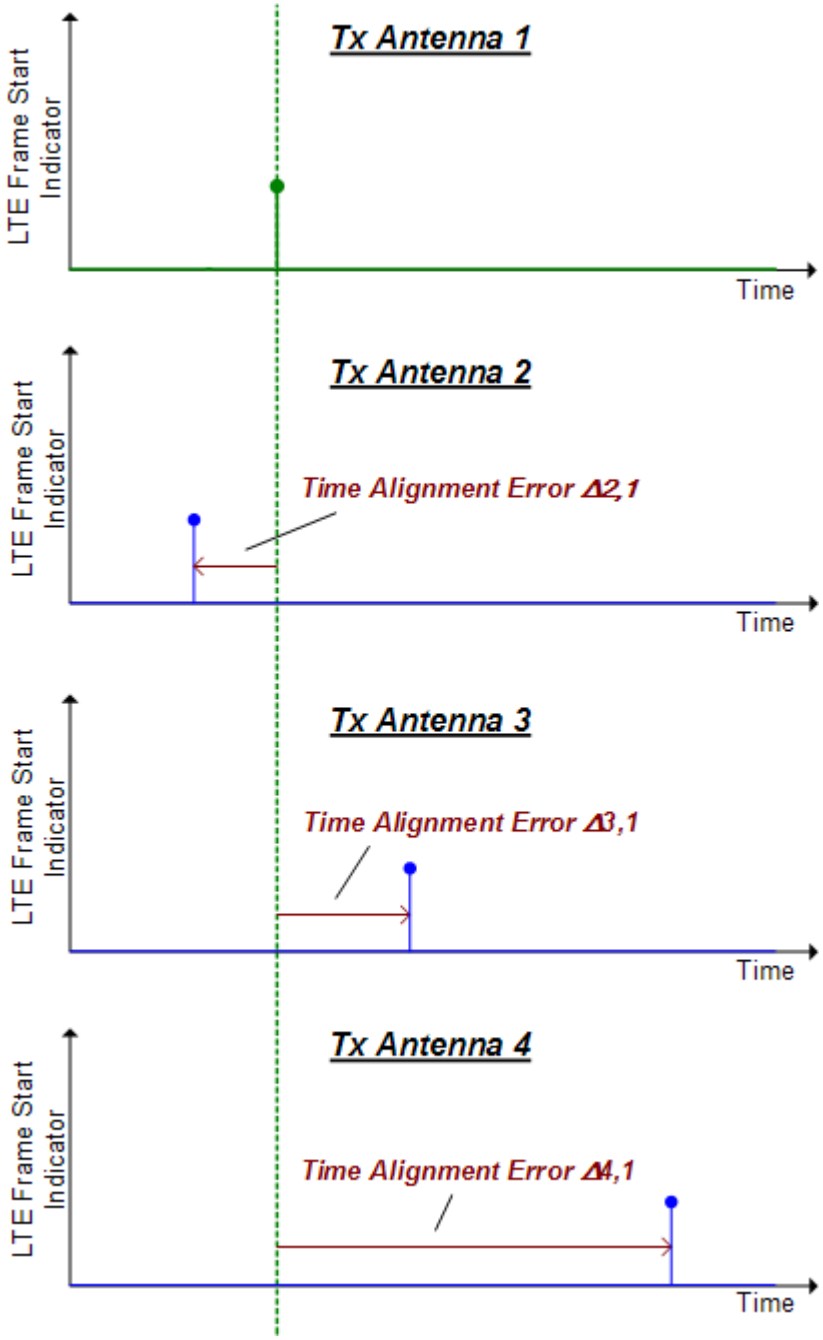


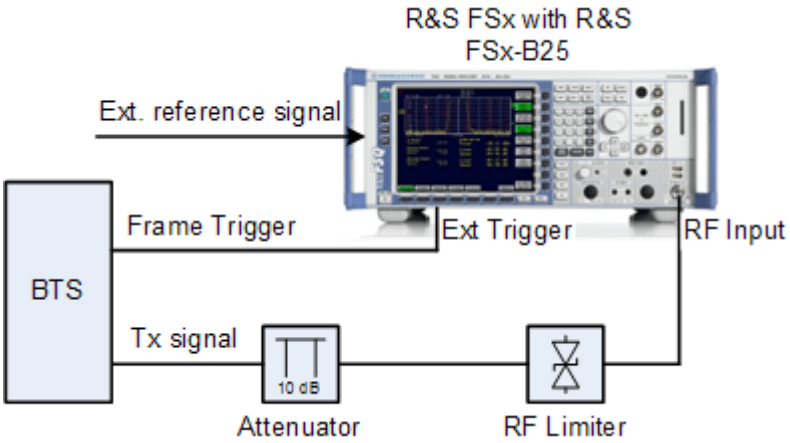
Fig. 4-3: Schematic description of the time alignment results

4.5 Performing Transmit On/Off Power Measurements

The technical specification in 3GPP TS 36.141 prescribes the measurement of the transmitter OFF power and the transmitter transient period of an EUTRA/LTE TDD base transceiver station (BTS) operating at its specified maximum output power. A special hardware setup is required for this measurement since the actual measurement is done

at very low power during the transmitter OFF periods requiring low attenuation at the analyzer input. The signal power during the transmitter ON periods in this test scenario is usually higher than the specified maximum input power of the R&S FSx signal analyzer and will cause severe damage to the analyzer if the measurement is not set up appropriately.

Test setup



To protect the analyzer input from damage, an RF limiter has to be applied at the analyzer input connector, as can be seen in figure 2-16. Table 1.1 shows the specifications the used limiter has to fulfill.

Min. acceptable CW input power	BTS output power minus 10 dB
Min. acceptable peak input power	BTS peak output power minus 10 dB
Max. output leakage	20 dBm
Max. response time	1 µs
Max. recovery time	1 µs

An additional 10 dB attenuation should be placed in front of the RF limiter to absorb eventual reflected waves because of the high VSWR of the limiter. The allowed maximum CW input power of the attenuator must be lower than the maximum output power of the BTS.

Performing the measurement

If an external trigger is used, before the actual measurement can be started, the timing must be adjusted by pressing the 'Adjust Timing' hotkey. The status display in the header of the graph changes from 'Timing not adjusted' to 'Timing adjusted' and the run hotkeys are released. Relevant setting changes again lead to a 'Timing not adjusted' status display.

If the adjustment fails, an error message is shown and the adjustment state is still "not adjusted". To find out what causes the synchronization failure, you should perform a regular EVM measurement (i.e. leave the ON/OFF Power measurement). Then you can use all the measurement results like EVM vs. Carrier to get more detailed information

about the failure. The timing adjustment will succeed if the Sync State in the header is OK.

Using a R&S FSQ or R&S FSG it is recommended to use the external trigger mode since for high power signals a successful synchronization is not guaranteed under certain circumstances.

Pressing the 'Run Single' hotkey starts the averaging of the traces of the number of frames given in the 'General Settings' dialog. After performing all sweeps, the table in the upper half of the screen shows if the measurements pass or fail.

5 Measurements and Result Displays

The LTE measurement application features several measurements to examine and analyze different aspects of an LTE signal.

The source of the data that is processed is either a live signal or a previously recorded signal whose characteristics have been saved to a file. For more information see "Selecting the Input Source" on page 60.

- Numerical Results....30
- Measuring the Power Over Time....33
- Measuring the Error Vector Magnitude (EVM)....35
- Measuring the Spectrum....38
- Measuring the Symbol Constellation....45
- Measuring Statistics....46

5.1 Numerical Results

Result Summary....30

Result Summary
The Result Summary shows all relevant measurement results in numerical form, combined in one table.

▸ Press the "Display (List Graph)" softkey so that the "List" element turns green to view the Result Summary.

SCPI command:

`DISPlay[:WINDow<n>]:TABLe` on page 91

Contents of the result summary

Result Summary						
Frame Result 1/1	Min	Mean	Limit	Max	Limit	Unit
EVM PDSCH QPSK		0.35	17.50			%
EVM PDSCH 16QAM			12.50			%
EVM PDSCH 64QAM			8.00			%
Time Alignment Error 2,1						ns
Time Alignment Error 3,1						ns
Time Alignment Error 4,1						ns
Results for Selection	Subframe(s) ALL	Selection Antenna 1		Frame Result 1/1		
EVM All	0.34	0.35		0.36		%
EVM Phys. Channel	0.34	0.35		0.36		%
EVM Phys. Signal	0.33	0.35		0.36		%
Frequency Error	- 35.44	- 35.36		- 35.26		Hz
Sampling Error	- 0.07	- 0.04		- 0.01		ppm
IQ Offset	- 68.33	- 67.16		- 66.53		dB
IQ Gain Imbalance	- 0.00	- 0.00		- 0.00		dB
IQ Quadrature Error	0.02	0.02		0.02		°
RSTP	- 57.96	- 57.95		- 57.95		dBm
OSTP	- 30.17	- 30.17		- 30.17		dBm
Power	- 30.25	- 30.23		- 30.22		dBm
Crest Factor		10.05				dB

The table is split in two parts. The first part shows results that refer to the complete frame. For each result, the minimum, mean and maximum values are displayed. It also indicates limit check results where available. The font of 'Pass' results is green and that of 'Fail' results is red.

In addition to the red font, the application also puts a red star (* 25.60) in front of failed results.

- **EVM PDSCH QPSK**
  Shows the EVM for all QPSK-modulated resource elements of the PDSCH channel in the analyzed frame.
  `FETCh:SUMMary:EVM:DSQP[:AVERage]?` on page 97
- **EVM PDSCH 16QAM**
  Shows the EVM for all 16QAM-modulated resource elements of the PDSCH channel in the analyzed frame.
  `FETCh:SUMMary:EVM:DSST[:AVERage]?` on page 98
- **EVM PDSCH 64QAM**
  Shows the EVM for all 64QAM-modulated resource elements of the PDSCH channel in the analyzed frame.
  `FETCh:SUMMary:EVM:DSSF[:AVERage]?` on page 98
- **Time Alignment Error 2,1 / 3,1 / 4,1**
  Shows the timing difference in MIMO setups between antenna 1 and another antenna (2, 3 or 4).
  `FETCh:SUMMary:TAE<antenna>?` on page 101

By default, all EVM results are in %. To view the EVM results in dB, change the EVM Unit.

The second part of the table shows results that refer to a specifc selection of the frame.

The statistic is always evaluated over the subframes.

The header row of the table contains information about the selection you have made (like the subframe).

- **EVM All**
  Shows the EVM for all resource elements in the analyzed frame.
  FETCh:SUMMary:EVM[:ALL][:AVERage]? on page 97
- **EVM Phys Channel**
  Shows the EVM for all physical channel resource elements in the analyzed frame.
  FETCh:SUMMary:EVM:PCHannel[:AVERage]? on page 98
- **EVM Phys Signal**
  Shows the EVM for all physical signal resource elements in the analyzed frame.
  FETCh:SUMMary:EVM:PSIGnal[:AVERage]? on page 99
- **Frequency Error**
  Shows the difference in the measured center frequency and the reference center frequency.
  FETCh:SUMMary:FERRor[:AVERage]? on page 99
- **Sampling Error**
  Shows the difference in measured symbol clock and reference symbol clock relative to the system sampling rate.
  FETCh:SUMMary:SERRor[:AVERage]? on page 101
- **I/Q Offset**
  Shows the power at spectral line 0 normalized to the total transmitted power.
  FETCh:SUMMary:IQOFfset[:AVERage]? on page 100
- **I/Q Gain Imbalance**
  Shows the logarithm of the gain ratio of the Q-channel to the I-channel.
  FETCh:SUMMary:GIMBalance[:AVERage]? on page 99
- **I/Q Quadrature Error**
  Shows the measure of the phase angle between Q-channel and I-channel deviating from the ideal 90 degrees.
  FETCh:SUMMary:QUADerror[:AVERage]? on page 101
- **RSTP**
  Shows the reference signal transmit power as defined in 3GPP TS 36.141.
  It is an average power and accumulates the powers of the reference symbols within a subframe divided by the number of reference symbols within a subframe.
  FETCh:SUMMary:RSTP[:AVERage]? on page 101
- **OSTP**
  Shows the OFDM symbol transmit power as defined in 3GPP TS 36.141.
  It accumulates all subcarrier powers of the 4th OFDM symbol. The 4th (out of 14 OFDM symbols within a subframe (in case of frame type 1, normal CP length)) contains exclusively PDSCH.
  FETCh:SUMMary:OSTP[:AVERage]? on page 100
- **Power**
  Shows the average time domain power of the analyzed signal.
  FETCh:SUMMary:POWer[:AVERage]? on page 100
- **Crest Factor**
  Shows the peak-to-average power ratio of captured signal.
  FETCh:SUMMary:CRESt[:AVERage]? on page 97

5.2 Measuring the Power Over Time

This chapter contains information on all measurements that show the power of a signal over time.

Capture Buffer.....33
On / Off Power.....34

Capture Buffer

The capture buffer result display shows the complete range of captured data for the last data capture. The x-axis represents the time scale. The maximum value of the x-axis is equal to the capture length that you can set in the General Settings dialog box. The y-axis represents the amplitude of the captured I/Q data in dBm (for RF input).

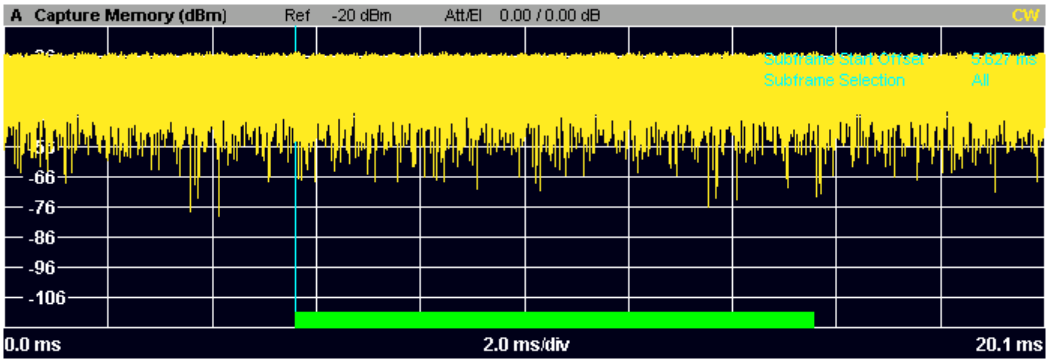


Fig. 5-1: Capture buffer without zoom

The header of the diagram shows the reference level, the mechanical and electrical attenuation and the trace mode.

The green bar at the bottom of the diagram represents the frame that is currently analyzed.

A blue vertical line at the beginning of the green bar in the Capture Buffer display marks the subframe start. Additionally, the diagram includes the Subframe Start Offset value (blue text). This value is the time difference between the subframe start and capture buffer start.

When you zoom into the diagram, you will see that the bar may be interrupted at certain positions. Each small bar indicates the useful parts of the OFDM symbol.

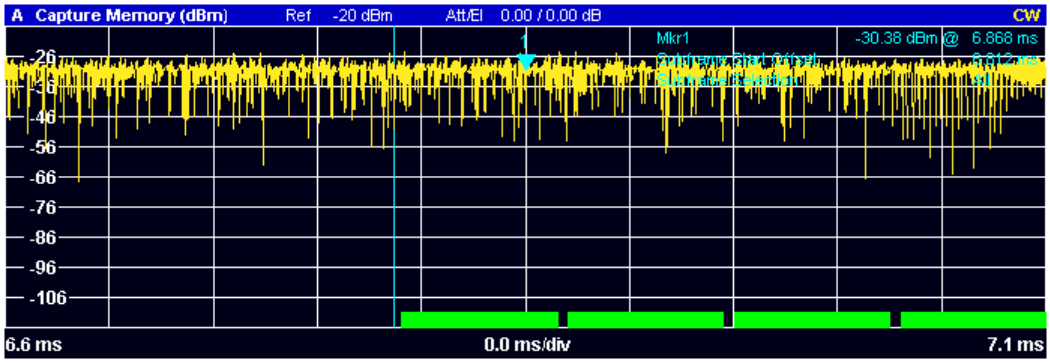


Fig. 5-2: Capture buffer after a zoom has been applied

SCPI command:
CALCulate<n>:FEED 'PVT:CBUF'
TRACe:DATA?

On / Off Power

The On/Off Power measurement shows the signal power of the signal over a particular time period. Its purpose is to verify if the transmitter OFF power is within the defined limits. The measurement is available for the TDD duplexing mode.

Note that the On/Off Power result display is based on different signal data than I/Q measurements. Thus, it is not possible to use the data captured for I/Q measurements for the On/Off Power measurement and vice versa. The measurement is available if the input source is an RF input source.

For more information on performing the measurement see chapter 4.5, "Performing Transmit On/Off Power Measurements", on page 27.

The upper part of the display shows the results of the measurement in numerical form.

A ON/OFF Power

Start OFF Period Limit	Stop OFF Period Limit	Time at Δ to Limit	OFF Power Abs[dBm]	OFF Power Δ to Limit	Falling Trans. Period	Rising Trans. Period
1.838 ms	4.948 ms	2.962891 ms	-86.21 dBm	11.21 dB	2.41 µs	2.44 µs

In a TDD LTE frame there are periods where no DL subframe signal is transmitted. Each of these periods consist of an ON-to-OFF transient, an OFF period and an OFF-to-ON transient. For each period, one line in the ON/OFF Power results table are shown.

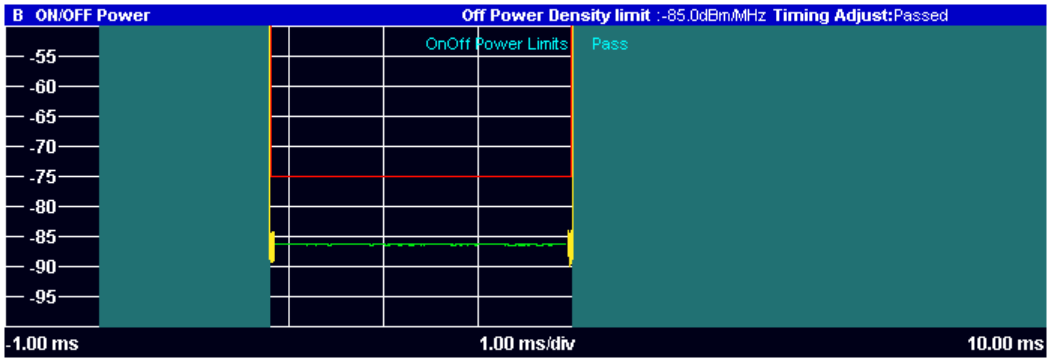
The Start and Stop OFF Period Limit gives the time period over which the OFF power is checked for limit fails. This is the length of the yellow trace.

For the OFF power trace maximum value (i.e. the value which has the lowest distance to the limit line in dB) the time in seconds relative to the frame start, the absolute OFF power value in dBm and the distance to the limit line in dB is given.

The length of the falling and rising transient is given in the last two columns of the table.

If any of the OFF power or transient results fail the limit check, the result will be printed in red color. The overall limit check result given in the header of the graph will pass if all of the limit checks of all periods are passed.

In the lower part of the screen an overview of the EUTRA/LTE frame is shown. Because of the overload during the ON period, only blue rectangles are sketched. The red line displays the limit to fulfill, the blue trace shows the transient period and the yellow trace shows the transmitter OFF power incorporating the filtering prescribed in 3GPP TS 36.141.



SCPI command:
Selection:
CALCulate<n>:FEED 'PVT:OOP'
Limit check:
`CALCulate<n>:LIMit<k>:OOPower:OFFPower?` on page 114
`CALCulate<n>:LIMit<k>:OOPower:TRANsient?` on page 114
`[SENSe][:LTE]:OOPower:ATIMing` on page 94
TRACe:DATA?

5.3 Measuring the Error Vector Magnitude (EVM)

This chapter contains information on all measurements that show the error vector magnitude (EVM) of a signal.

The EVM is one of the most important indicators for the quality of a signal. For more information on EVM calculation methods refer to chapter 4, "Measurement Basics", on page 21.

EVM vs Carrier.....35
EVM vs Symbol.....36
Frequency Error vs Symbol.....37
EVM vs Subframe.....38

EVM vs Carrier
Starts the EVM vs Carrier result display.

This result display shows the Error Vector Magnitude (EVM) of the subcarriers. With the help of a marker, you can use it as a debugging technique to identify any subcarriers whose EVM is too high.

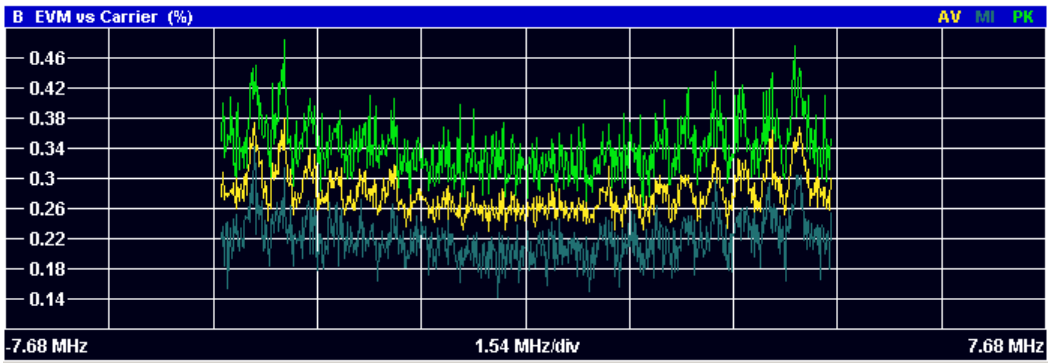
The results are based on an average EVM that is calculated over the OFDM symbols used by the subcarriers. This average subcarrier EVM is determined for each analyzed subframe in the capture buffer.

If you analyze all subframes, the result display contains three traces.

- Average EVM
  This trace shows the subcarrier EVM averaged over all subframes.
- Minimum EVM
  This trace shows the lowest (average) subcarrier EVM that has been found over the analyzed subframes.
- Maximum EVM
  This trace shows the highest (average) subcarrier EVM that has been found over the analyzed subframes.

If you select and analyze one subframe only, the result display contains one trace that shows the subcarrier EVM for that subframe only. Average, minimum and maximum values in that case are the same. For more information see "Subframe Selection" on page 78

The x-axis represents the center frequencies of the subcarriers. On the y-axis, the EVM is plotted either in % or in dB, depending on the EVM Unit.



SCPI command:
CALCulate<n>:FEED 'EVM:EVCA'
TRACe:DATA?

EVM vs Symbol
Starts the EVM vs Symbol result display.

This result display shows the Error Vector Magnitude (EVM) of the OFDM symbols. You can use it as a debugging technique to identify any symbols whose EVM is too high.

The results are based on an average EVM that is calculated over all subcarriers that are part of a particular OFDM symbol. This average OFDM symbol EVM is determined for each analyzed subframe.

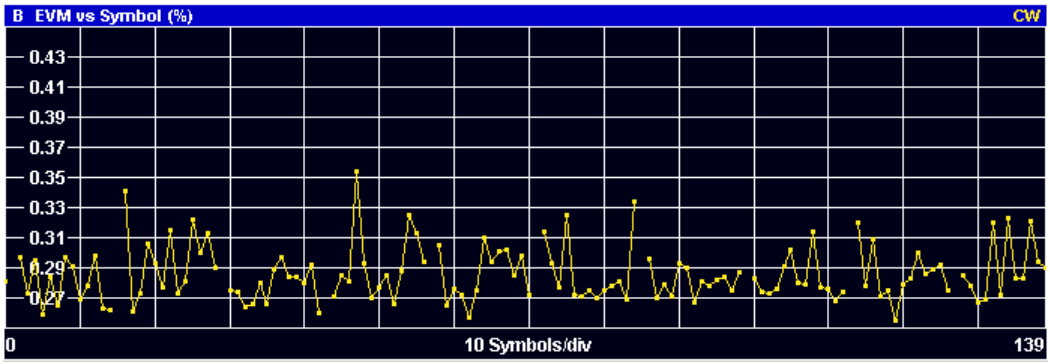
If you analyze all subframes, the result display contains three traces.

- Average EVM
  This trace shows the OFDM symbol EVM averaged over all subframes.
- Minimum EVM
  This trace shows the lowest (average) OFDM symbol EVM that has been found over the analyzed subframes.
- Maximum EVM
  This trace shows the highest (average) OFDM symbol EVM that has been found over the analyzed subframes.

If you select and analyze one subframe only, the result display contains one trace that shows the OFDM symbol EVM for that subframe only. Average, minimum and maximum values in that case are the same. For more information see "Subframe Selection" on page 78

The x-axis represents the OFDM symbols, with each symbol represented by a dot on the line. The number of displayed symbols depends on the Subframe Selection and the length of the cyclic prefix. Any missing connections from one dot to another mean that the R&S FSQ could not determine the EVM for that symbol. In case of TDD signals, the result display does not show OFDM symbols that are not part of the measured link direction.

On the y-axis, the EVM is plotted either in % or in dB, depending on the EVM Unit



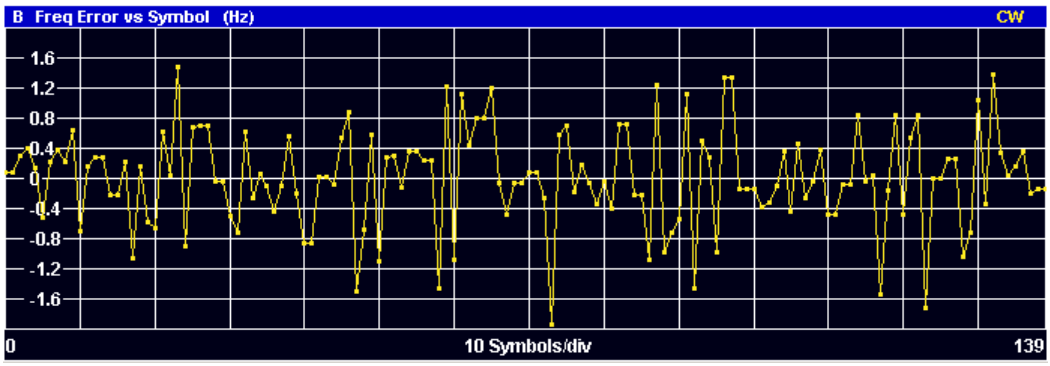
SCPI command:
CALCulate<n>:FEED 'EVM:EVSY'
TRACe:DATA?

Frequency Error vs Symbol
Starts the Frequency Error vs Symbol result display.

This result display shows the Frequency Error on symbol level. You can use it as a debugging technique to identify any frequency errors within symbols.

The result is an average over all subcarriers.

The x-axis represents the OFDM symbols, with each symbol represented by a dot on the line. The number of displayed symbols depends on the Subframe Selection and the length of the cyclic prefix. Any missing connections from one dot to another mean that the R&S FSQ could not determine the frequency error for that symbol. On the y-axis, the frequency error is plotted in Hz.



SCPI command:
CALCulate<n>:FEED 'EVM:FEVS'
TRACe:DATA?

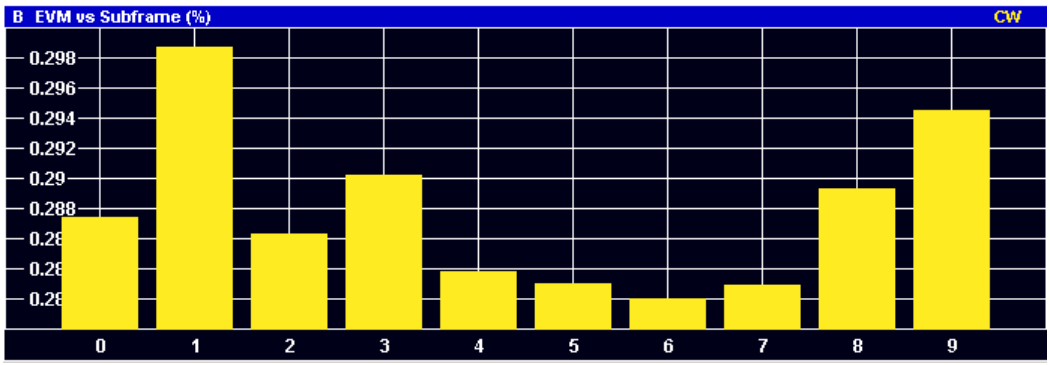
EVM vs Subframe
Starts the EVM vs Subframe result display.

This result display shows the Error Vector Magnitude (EVM) for each subframe. You can use it as a debugging technique to identify a subframe whose EVM is too high.

The result is an average over all subcarriers and symbols of a specific subframe.

The x-axis represents the subframes, with the number of displayed subframes being 10.

On the y-axis, the EVM is plotted either in % or in dB, depending on the EVM Unit.



SCPI command:
CALCulate<n>:FEED 'EVM:EVSU'
TRACe:DATA?

5.4 Measuring the Spectrum

This chapter contains information on all measurements that show the power of a signal in the frequency domain.

In addition to the I/Q measurements, spectrum measurements also include two frequency sweep measurements, the Spectrum Emission Mask and the Adjacent Channel Leakage Ratio.

- Frequency Sweep Measurements....39
- I/Q Measurements....42

5.4.1 Frequency Sweep Measurements

The Spectrum Emission Mask (SEM) and Adjacent Channel Leakage Ratio (ACLR) measurements are the only frequency sweep measurements available for the LTE measurement application. They do not use the I/Q data all other measurements use. Instead those measurements sweep the frequency spectrum every time you run a new measurement. Therefore it is not possible to to run an I/Q measurement and then view the results in the frequency sweep measurements and vice-versa. Also because each of the frequency sweep measurements uses different settings to obtain signal data it is not possible to run a frequency sweep measurement and view the results in another frequency sweep measurement.

Frequency sweep measurements are available if RF input is selected.

5.4.1.1 Available Measurements

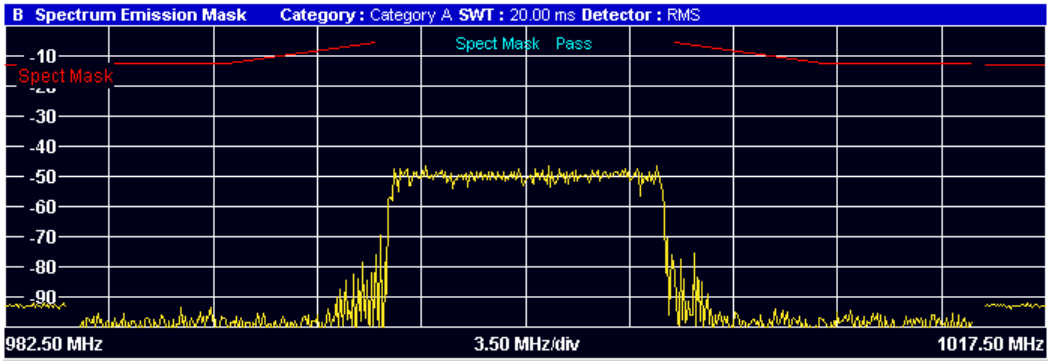
Spectrum Mask....39
ACLR....41

Spectrum Mask
Starts the Spectrum Emission Mask (SEM) result display.

The Spectrum Emission Mask measurement shows the quality of the measured signal by comparing the power values in the frequency range near the carrier against a spectral mask that is defined by the 3GPP specifications. In this way, you can test the performance of the DUT and identify the emissions and their distance to the limit.

In the diagram, the SEM is represented by a red line. If any measured power levels are above that limit line, the test fails. If all power levels are inside the specified limits, the test is passed. The R&S FSQ puts a label to the limit line to indicate whether the limit check passed or failed.

The x-axis represents the frequency with a frequency span that relates to the specified EUTRA/LTE channel bandwidths. On the y-axis, the power is plotted in dBm.



A table above the result display contains the numerical values for the limit check at each check point:

- **Start / Stop Freq Rel**
  Shows the start and stop frequency of each section of the Spectrum Mask relative to the center frequency.
- **RBW**
  Shows the resolution bandwidth of each section of the Spectrum Mask
- **Freq at Δ to Limit**
  Shows the absolute frequency whose power measurement being closest to the limit line for the corresponding frequency segment.
- **Power Abs**
  Shows the absolute measured power of the frequency whose power is closest to the limit. The application evaluates this value for each frequency segment.
- **Power Rel**
  Shows the distance from the measured power to the limit line at the frequency whose power is closest to the limit. The application evaluates this value for each frequency segment.
- **Δ to Limit**
  Shows the minimal distance of the tolerance limit to the SEM trace for the corresponding frequency segment. Negative distances indicate the trace is below the tolerance limit, positive distances indicate the trace is above the tolerance limit.

A Spectrum Emission Mask List Ref -26.2 dBm Att/El 0.00 / 0.00 dB

Start Freq. Rel.	Stop Freq. Rel.	RBW	Freq. at Δ to Limit	Power Abs.	Power Rel.	Δ to Limit
-17.50 MHz	-15.50 MHz	1.00 MHz	983.453504000 MHz	-92.05 dBm	-61.65 dB	-79.05 dB
-15.05 MHz	-10.05 MHz	100.00 kHz	989.399040000 MHz	-93.46 dBm	-63.05 dB	-80.96 dB
-10.05 MHz	-5.05 MHz	100.00 kHz	994.950016000 MHz	-75.77 dBm	-45.37 dB	-70.27 dB
5.05 MHz	10.05 MHz	100.00 kHz	1.005665088 GHz	-75.44 dBm	-45.03 dB	-69.08 dB
10.05 MHz	15.05 MHz	100.00 kHz	1.010937472 GHz	-94.43 dBm	-64.03 dB	-81.93 dB
15.50 MHz	17.50 MHz	1.00 MHz	1.016883008 GHz	-92.15 dBm	-61.74 dB	-79.15 dB

SCPI command:
CALCulate<n>:FEED 'SPEC:SEM'
TRACe:DATA?

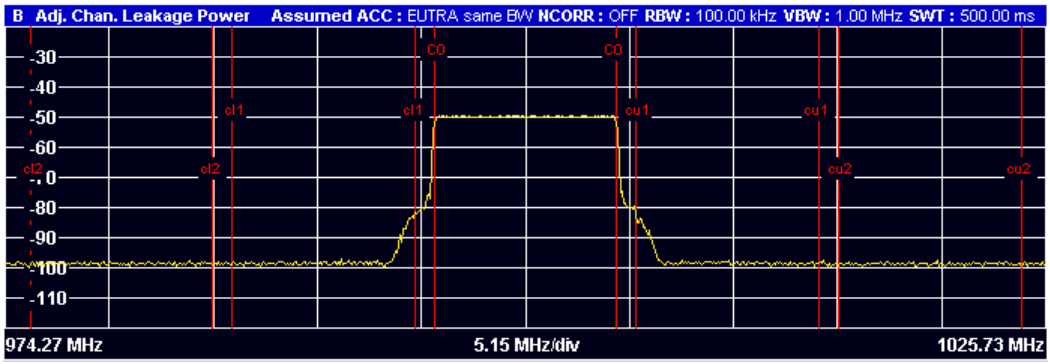
ACLR
Starts the Adjacent Channel Leakage Ratio (ACLR) measurement.

The Adjacent Channel Leakage Ratio measures the power of the TX channel and the power of adjacent and alternate channels to the left and right side of the TX channel. In this way, you can get information about the power of the channels adjacent to the transmission channel and the leakage into adjacent channels.

The results show the relative power measured in the two nearest channels either side of the transmission channel.

By default the ACLR settings are derived from the LTE Channel Bandwidth. You can change the assumed adjacent channel carrier type and the "Noise Correction" on page 58.

The x-axis represents the frequency with a frequency span that relates to the specified EUTRA/LTE channel and adjacent bandwidths. On the y-axis, the power is plotted in dBm.



A table above the result display contains information about the measurement in numerical form:

- **Channel**
  Shows the channel type (TX, Adjacent or Alternate Channel).
- **Bandwidth**
  Shows the bandwidth of the channel.
- **Spacing**
  Shows the channel spacing.
- **Lower / Upper**
  Shows the relative power of the lower and upper adjacent and alternate channels
- **Limit**
  Shows the limit of that channel, if one is defined.

A Adj. Chan. Leakage Power Ratio List Ref -26.2 dBm Att/El 0.00 / 0.00 dB
Channel | Bandwidth | Spacing | Lower | Upper | Limit
TX | 9.015 MHz | ... | -30.53 dB | | ...
Adjacent | 9.015 MHz | 10.00 MHz | -44.30 dB | -44.72 dB | -45.00 dB
Alternate | 9.015 MHz | 20.00 MHz | -48.75 dB | -48.88 dB | -45.00 dB

SCPI command:
Selection:
CALCulate<n>:FEED 'SPEC:ACP'
Reading results:
CALCulate<n>:MARKer<m>:FUNCtion:POWer:RESult[:CURRent]?
on page 114
TRACe:DATA?

5.4.2 I/Q Measurements

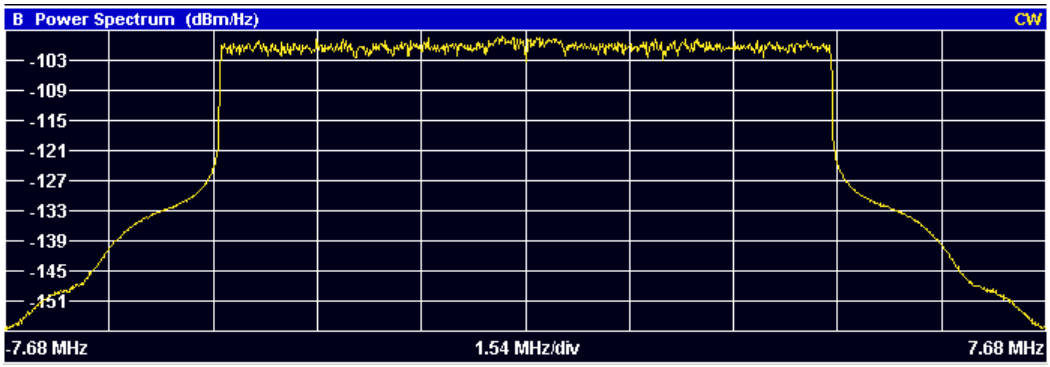
Power Spectrum....42
Power vs Resource Block PDSCH....43
Power vs Resource Block RS....43
Channel Flatness....44
Channel Group Delay....44
Channel Flatness Difference....45

Power Spectrum
Starts the Power Spectrum result display.

This result display shows the power density of the complete capture buffer in dBm/Hz. The displayed bandwidth depends on bandwidth or number of resource blocks you have set.

For more information see "Channel Bandwidth / Number of Resource Blocks" on page 51.

The x-axis represents the frequency. On the y-axis the power level is plotted.



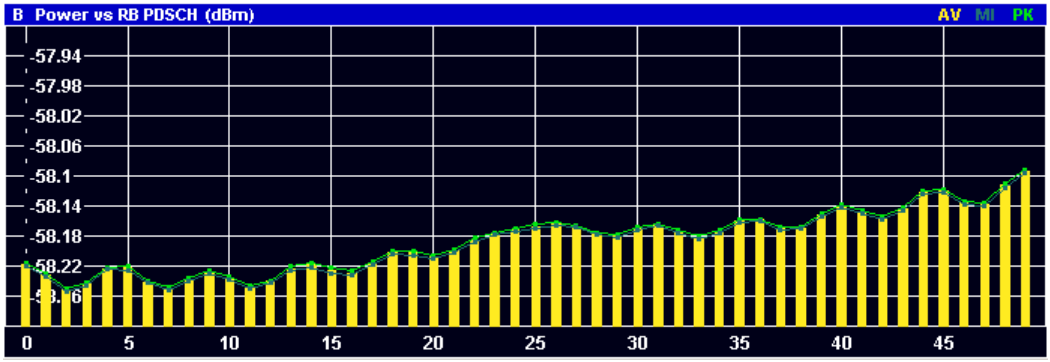
SCPI command:
CALCulate<screenid>:FEED 'SPEC:PSPE'
TRACe:DATA?

Power vs Resource Block PDSCH
Starts the Power vs Resource Block PDSCH result display.

This result display shows the power of the physical downlink shared channel per resource block.

By default, three traces are shown. One trace shows the average power. The second and the third trace show the minimum and maximum powers respectively. You can select to display the power for a specific subframe in the Subframe Selection dialog box. In that case, the application shows the powers of that subframe only.

The x-axis represents the resource blocks. The displayed number of resource blocks depends on the channel bandwidth or number of resource blocks you have set. On the y-axis, the power is plotted in dBm.



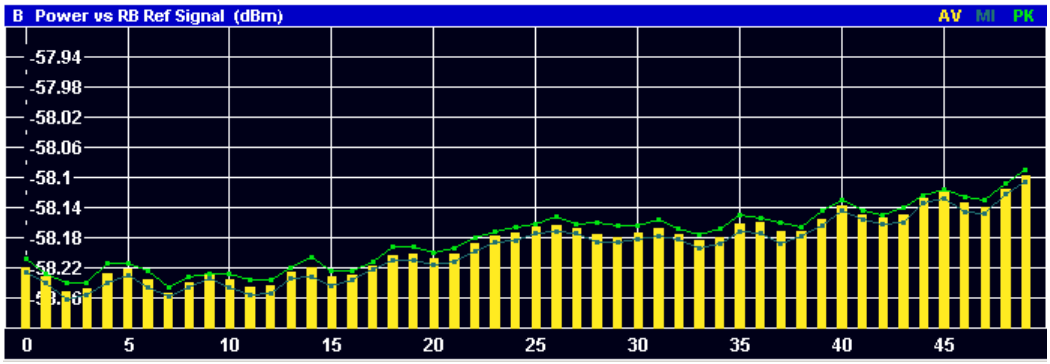
SCPI command:
CALCulate<n>:FEED 'SPEC:PVRP'
TRACe:DATA?

Power vs Resource Block RS
Starts the Power vs Resource Block RS result display.

This result display shows the power of the reference signal per resource block.

By default, three traces are shown. One trace shows the average power. The second and the third trace show the minimum and maximum powers respectively. You can select to display the power for a specific subframe in the Subframe Selection dialog box. In that case, the application shows the power of that subframe only.

The x-axis represents the resource blocks. The displayed number of resource blocks depends on the channel bandwidth or number of resource blocks you have set. On the y-axis, the power is plotted in dBm.



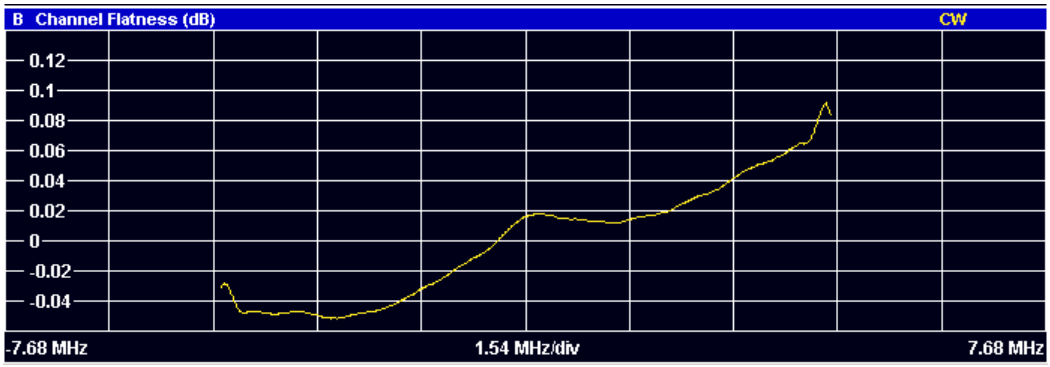
SCPI command:
CALCulate<n>:FEED 'SPEC:PVRR'
TRACe:DATA?

Channel Flatness
Starts the Channel Flatness result display.

This result display shows the relative power offset caused by the transmit channel.

The currently selected subframe depends on your selection.

The x-axis represents the frequency. On the y-axis, the channel flatness is plotted in dB.



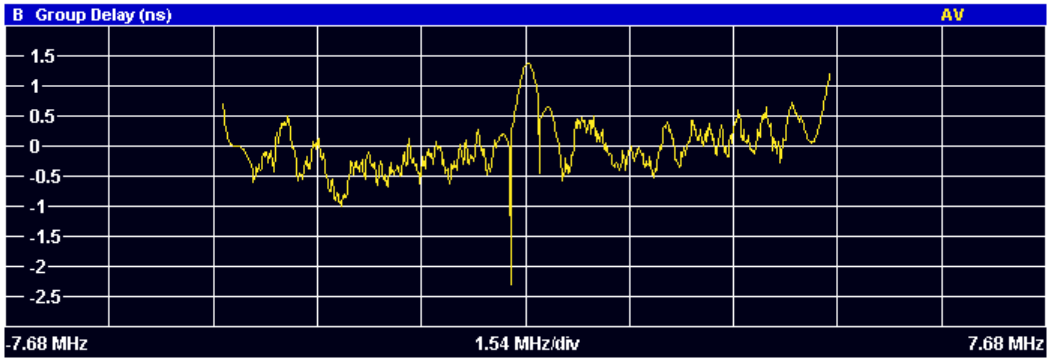
SCPI command:
CALCulate<n>:FEED 'SPEC:FLAT'
TRACe:DATA?

Channel Group Delay
Starts the Channel Group Delay result display.

This result display shows the group delay of each subcarrier.

The currently selected subframe depends on your selection.

The x-axis represents the frequency. On the y-axis, the group delay is plotted in ns.



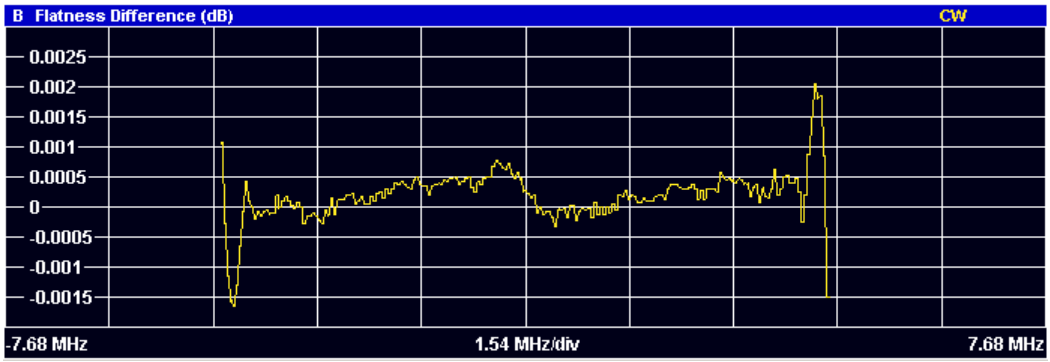
SCPI command:
CALCulate<n>:FEED 'SPEC:GDEL'
TRACe:DATA?

Channel Flatness Difference
Starts the Channel Flatness Difference result display.

This result display shows the level difference in the spectrum flatness result between two adjacent physical subcarriers.

The currently selected subframe depends on your selection.

The x-axis represents the frequency. On the y-axis, the power is plotted in dB.



SCPI command:
CALCulate<n>:FEED 'SPEC:FDIF'
TRACe:DATA?

5.5 Measuring the Symbol Constellation

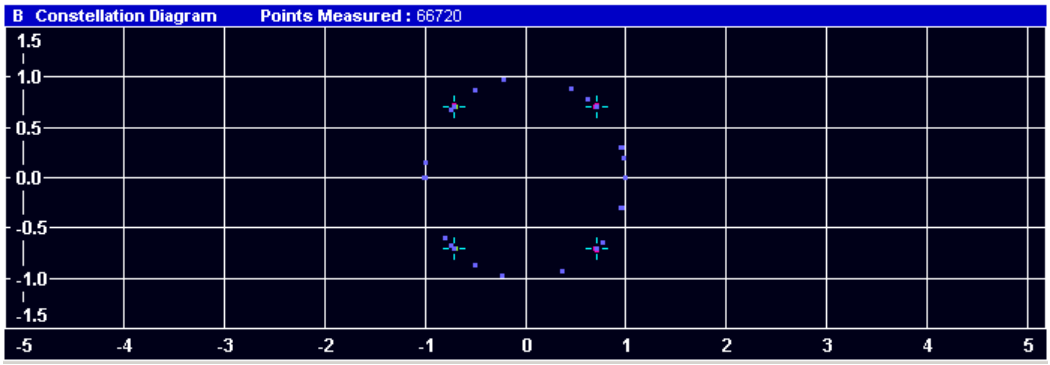
This chapter contains information on all measurements that show the constellation of a signal.

Constellation Diagram.....45

Constellation Diagram
Starts the Constellation Diagram result display.

This result display shows the inphase and quadrature phase results and is an indicator of the quality of the modulation of the signal. The result display evaluates the full range of the measured input data. You can filter the results in the Constellation Selection dialog box.

The ideal points for the selected modulation scheme are displayed for reference purposes.



SCPI command:
CALCulate<n>:FEED 'CONS:CONS'
TRACe:DATA?

5.6 Measuring Statistics

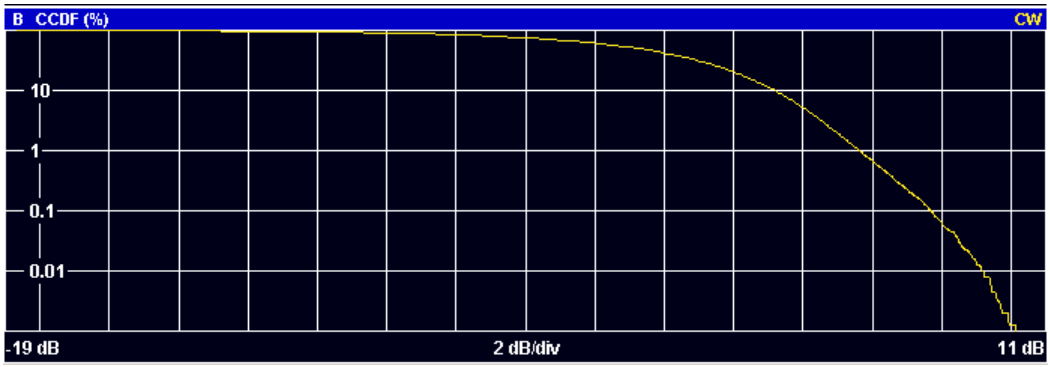
This chapter contains information on all measurements that show the statistics of a signal.

CCDF....46
Allocation Summary....47
Bit Stream....48

CCDF
Starts the Complementary Cumulative Distribution Function (CCDF) result display.

This result display shows the probability of an amplitude exceeding the mean power. For the measurement, the complete capture buffer is used.

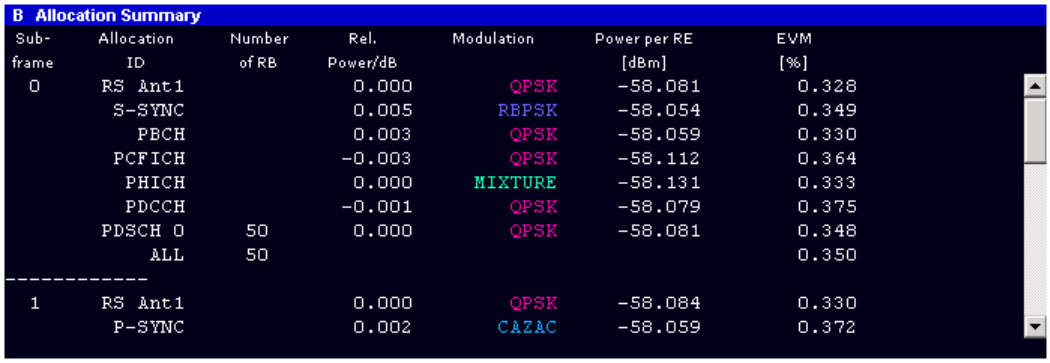
The x-axis represents the power relative to the measured mean power. On the y-axis, the probability is plotted in %.



SCPI command:
CALCulate<n>:FEED 'STAT:CCDF'
TRACe:DATA?

Allocation Summary
Starts the Allocation Summary result display.

This result display shows the results of the measured allocations in tabular form.


B Allocation Summary
Sub-frame | Allocation ID | Number of RB | Rel. Power/dB | Modulation | Power per RE [dBm] | EVM [%]
0 | RS Ant1 | | 0.000 | QPSK | -58.081 | 0.328
S-SYNC | | 0.005 | RBPSK | -58.054 | 0.349
PBCH | | 0.003 | QPSK | -58.059 | 0.330
PCFICH | | -0.003 | QPSK | -58.112 | 0.364
PHICH | | 0.000 | MIXTURE | -58.131 | 0.333
PDCCH | | -0.001 | QPSK | -58.079 | 0.375
PDSCH 0 | 50 | 0.000 | QPSK | -58.081 | 0.348
ALL | 50 | | | | 0.350
1 | RS Ant1 | | 0.000 | QPSK | -58.084 | 0.330
P-SYNC | | 0.002 | CAZAC | -58.059 | 0.372

The rows in the table represent the allocations, with allocation ALL being a special allocation that summarizes all allocations that are part of the subframe. A set of allocations form a subframe. The subframes are separated by a dashed line. The columns of the table contain the following information:

The rows in the table represent the allocations. A set of allocations form a subframe. The subframes are separated by a dashed line. The columns of the table contain the follwing information:

- **Subframe**
  Shows the subframe number.
- **Allocation ID**
  Shows the type / ID of the allocation.
- **Number of RB**
  Shows the number of resource blocks assigned to the current PDSCH allocation.
- **Rel. Power/dB**
  Shows the relative power of the allocation.
- **Modulation**
  Shows the modulation type.
- **Power per RE [dBm]**
  Shows the power of each resource element in dBm.

- **EVM**
  Shows the EVM of the allocation. The unit depends on your selection.

SCPI command:
CALCulate<n>:FEED 'STAT:ASUM'
TRACe:DATA?

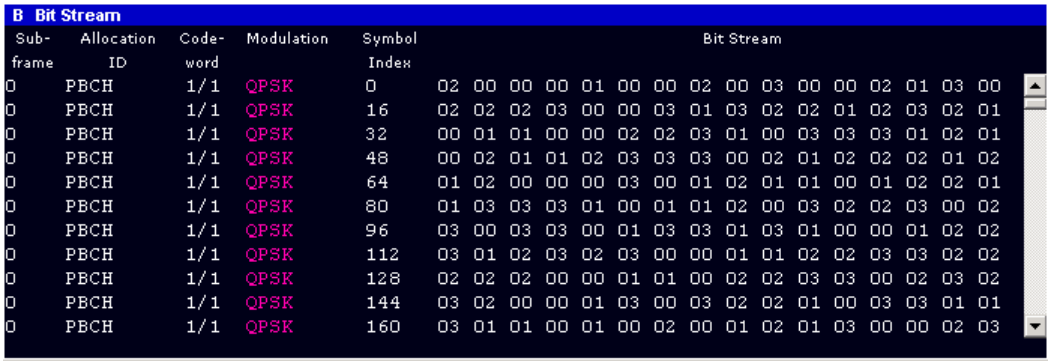
Bit Stream
Starts the Bit Stream result display.

This result display shows the demodulated data stream for each data allocation. Depending on the Bit Stream Format, the numbers represent either bits (bit order) or symbols (symbol order).

Selecting symbol format shows the bit stream as symbols. In that case the bits belonging to one symbol are shown as hexadecimal numbers with two digits. In the case of bit format, each number represents one raw bit.

Symbols or bits that are not transmitted are represented by a "-".

If a symbol could not be decoded because the number of layers exceeds the number of receive antennas, the application shows a "#" sign.


B Bit Stream

Sub-frame	Allocation ID	Code-word	Modulation	Symbol Index	Bit Stream
0	PBCH	1/1	QPSK	0	02 00 00 00 01 00 00 02 00 03 00 00 02 01 03 00
0	PBCH	1/1	QPSK	16	02 02 02 03 00 00 03 01 03 02 02 01 02 03 02 01
0	PBCH	1/1	QPSK	32	00 01 01 00 00 02 02 03 01 00 03 03 03 01 02 01
0	PBCH	1/1	QPSK	48	00 02 01 01 02 03 03 03 00 02 01 02 02 02 01 02
0	PBCH	1/1	QPSK	64	01 02 00 00 00 03 00 01 02 01 01 00 01 02 02 01
0	PBCH	1/1	QPSK	80	01 03 03 03 01 00 01 01 02 00 03 02 02 03 00 02
0	PBCH	1/1	QPSK	96	03 00 03 03 00 01 03 03 01 03 01 00 00 01 02 02
0	PBCH	1/1	QPSK	112	03 01 02 03 02 03 00 00 01 01 02 02 03 03 02 02
0	PBCH	1/1	QPSK	128	02 02 02 00 00 01 01 00 02 02 03 03 00 02 03 02
0	PBCH	1/1	QPSK	144	03 02 00 00 01 03 00 03 02 02 01 00 03 03 01 01
0	PBCH	1/1	QPSK	160	03 01 01 00 01 00 02 00 01 02 01 03 00 00 02 03

The table contains the following information:

- **Subframe**
  Number of the subframe the bits belong to.
- **Allocation ID**
  Channel the bits belong to.
- **Codeword**
  Code word of the allocation.
- **Modulation**
  Modulation type of the channels.
- **Bit / Symbol Index**
  Shows the position of the table row's first bit or symbol within the complete stream.
- **Bit Stream**
  The actual bit stream.

SCPI command:
CALCulate<n>:FEED 'STAT:BSTR'
TRACe:DATA?

6 Configuring and Performing the Measurement

Before you can start a measurement, you have to configure the R&S FSQ in order to get valid measurement results. This chapter contains detailed information on all settings available in the application.

You can access the two main settings dialog boxes via the "Settings (Gen Demod)" softkey. Pressing the softkey once opens the "General Settings" dialog box. The "Gen" label in the softkey turns green to indicate an active "General Settings" dialog box. Pressing the softkey again opens the "Demod Settings" dialog box. When the "Demod Settings" dialog box is active, the "Demod" label in the softkey turns green.

In the "General Settings" dialog box, you can set all parameters that are related to the overall measurement. The dialog box is made up of three tabs, one for general settings, one for MIMO settings and one for advanced settings. By default, the "General" tab is the active one.

In the "Demod Settings" dialog box you can set up the measurement in detail, e.g. the demodulation configuration. The dialog box is made up of three tabs, one for configuring the signal configuration, one for setting up the frame configuration and one for configuring the control channels and miscellaneous settings. By default, the "DL Demod" tab is the active one.

You can switch between the tabs with the cursor keys.

- Performing Measurements....49
- General Settings....50
- Configuring MIMO Setups....57
- Configuring Spectrum Measurements....57
- Advanced General Settings....59
- Configuring Downlink Signal Demodulation....63
- Configuring Downlink Frames....67
- Defining Advanced Signal Characteristics....72

6.1 Performing Measurements

The sweep menu contains functions that control the way the R&S FSQ performs a measurement.

Single Sweep and Continuous Sweep
In continuous sweep mode, the R&S FSQ continuously captures data, performs measurements and updates the result display according to the trigger settings.

To activate single sweep mode, press the "Run Single" softkey. In single sweep mode, the R&S FSQ captures data, performs the measurement and updates the result display exactly once after the trigger event. After this process, the R&S FSQ interrupts the measurement.

You can always switch back to continuous sweep mode with the "Run Cont" softkey.

SCPI command:
INITiate:CONTinuous on page 93

Auto Level
The "Auto Level" softkey initiates a process that sets an ideal reference level for the current measurement.

For more information see "Defining a Reference Level" on page 52.

SCPI command:
[SENSe]:POWer:AUTO<analyzer>[:STATe] on page 119

Refresh
Updates the current result display in single sweep mode without capturing I/Q data again.

If you have changed any settings after a single sweep and use the Refresh function, the R&S FSQ updates the current measurement results with respect to the new settings. It does not capture I/Q data again but uses the data captured last.

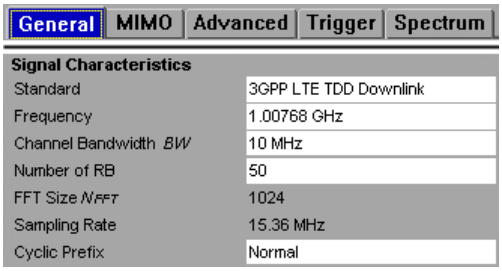
SCPI command:
INITiate:REFResh on page 94

6.2 General Settings

6.2.1 Defining Signal Characteristics

The general signal characteristics contain settings to describe the general physical attributes of the signal.

The signal characteristics are part of the "General" tab of the "General Settings" dialog box.



Selecting the LTE Mode....50
Defining the Signal Frequency....51
Channel Bandwidth / Number of Resource Blocks....51
Cyclic Prefix....52

Selecting the LTE Mode
The standard defines the LTE mode you are testing.

The choices you have depend on the configuration of the R&S FSQ.

- option FSx-K100(PC) enables testing of 3GPP LTE FDD signals on the downlink
- option FSx-K101(PC) enables testing of 3GPP LTE FDD signals on the uplink
- option FSx-K102(PC) enables testing of 3GPP LTE MIMO signals on the downlink
- option FSx-K104(PC) enables testing of 3GPP LTE TDD signals on the downlink
- option FSx-K105(PC) enables testing of 3GPP LTE TDD signals on the uplink

FDD and TDD are **duplexing** methods.

- FDD mode uses different frequencies for the uplink and the downlink.
- TDD mode uses the same frequency for the uplink and the downlink.

Downlink (DL) and Uplink (UL) describe the **transmission path**.

- Downlink is the transmission path from the base station to the user equipment. The physical layer mode for the downlink is always OFDMA.
- Uplink is the transmission path from the user equipment to the base station. The physical layer mode for the uplink is always SC-FDMA.

SCPI command:

`CONFigure[:LTE]:LDIRection` on page 117

`CONFigure[:LTE]:DUPLexing` on page 117

Defining the Signal Frequency

For measurements with an RF input source, you have to match the **center frequency** of the analyzer to the frequency of the signal.

The available frequency range depends on the hardware configuration of the analyzer you are using.

The frequency setting is available for the RF input source.

SCPI command:
Center frequency:

`[SENSe]:FREQuency:CENTer` on page 117

Channel Bandwidth / Number of Resource Blocks

Specifies the channel bandwidth and the number of resource blocks (RB).

The channel bandwidth and number of resource blocks (RB) are interdependent. If you enter one, the R&S FSQ automatically calculates and adjusts the other.

Currently, the LTE standard recommends six bandwidths (see table below).

If you enter a value different to those recommended by the standard, the R&S FSQ labels the parameter as "User", but still does the calculations.

The R&S FSQ also calculates the FFT size and sampling rate from the channel bandwidth. Those are read only.

Channel Bandwidth [MHz]	1.4	3	5	10	15	20
Number of Resource Blocks	6	15	25	50	75	100
Sample Rate [MHz]	1.92	3.84	7.68	15.36	23.04	30.72
FFT Size	128	256	512	1024	2048	2048

SCPI command:
`CONFigure[:LTE]:DL:BW` on page 116
`CONFigure[:LTE]:DL:NORB` on page 116

Cyclic Prefix
The cyclic prefix serves as a guard interval between OFDM symbols to avoid interferences. The standard specifies two cyclic prefix modes with a different length each.

The cyclic prefix mode defines the number of OFDM symbols in a slot.

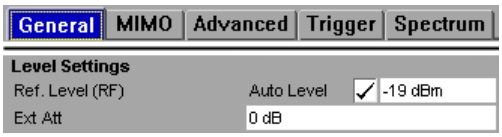
- Normal
  A slot contains 7 OFDM symbols.
- Extended
  A slot contains 6 OFDM symbols.
  The extended cyclic prefix is able to cover larger cell sizes with higher delay spread of the radio channel.
- Auto
  The application automatically detects the cyclic prefix mode in use.

SCPI command:
`CONFigure[:LTE]:DL:CYCPrefix` on page 116

6.2.2 Configuring the Input Level

The level settings contain settings that control the input level of the analyzer.

The level settings are part of the "General" tab of the "General Settings" dialog box.



Defining a Reference Level....52
Attenuating the Signal....53

Defining a Reference Level
The reference level is the power level the R&S FSQ expects at the RF input. Keep in mind that the power level at the RF input is the peak envelope power in case of signals with a high crest factor like LTE.

To get the best dynamic range, you have to set the reference level as low as possible. At the same time, make sure that the maximum signal level does not exceed the reference level. If it does, it will overload the A/D converter, regardless of the signal power. Measurement results may deteriorate (e.g. EVM). This applies especially for measurements with more than one active channel near the one you are trying to measure (± 6 MHz).

Note that the signal level at the A/D converter may be stronger than the level the application displays, depending on the current resolution bandwidth. This is because the resolution bandwidths are implemented digitally after the A/D converter.

You can either specify the **RF Reference Level** (in dBm) or **Baseband Reference Level** (in V), depending on the input source.

You can also use **automatic detection** of the reference level with the "Auto Level" function.

If active, the application measures and sets the reference level to its ideal value before each sweep. This process slightly increases the measurement time. You can define the measurement time of that measurement with the **Auto Level Track Time**.

Automatic level detection also optimizes RF attenuation.

SCPI command:
Manual (RF):
`CONFigure:POWer:EXPected:RF<analyzer>` on page 118
Manual (BB):
`CONFigure:POWer:EXPected:IQ<analyzer>` on page 118
Automatic:
`[SENSe]:POWer:AUTO<analyzer>[:STATe]` on page 119
Auto Level Track Time:
`[SENSe]:POWer:AUTO<analyzer>:TIME` on page 120

Attenuating the Signal
Attenuation of the signal may become necessary if you have to reduce the power of the signal that you have applied. Power reduction is necessary, for example, to prevent an overload of the input mixer.

The LTE application provides several attenuation modes.

- **External** attenuation is always available. It controls an external attenuator if you are using one.
- **Mechanical** (or RF) attenuation is always available. The mechanical attenuator controls attenuation at the RF input.
  Mechanical attenuation is available in the "Advanced" tab of the "General Settings" dialog box.
- If you have equipped your R&S FSQ with option R&S FSQ-B25, it also provides **electronic** attenuation. Note that the frequency range may not exceed the specification of the electronic attenuator for it to work.
  Electronic attenuation is available in the "Advanced" tab of the "General Settings" dialog box.

Positive values correspond to an attenuation and negative values correspond to an amplification.

RF attenuation is independent of the reference level. It is available if automatic reference level detection is inactive. The range is from 0 dB to 75 dB.

The process of configuring the electronic attenuator consists of three steps.

- Selecting the mode
  You can select either manual or automatic control of the electronic attenuator.
- Selecting the state
  Turns the electronic attenuator on and off.
- Setting the attenuation level
  Sets the degree of electronic attenuation.

If you have selected automatic attenuation, the R&S FSQ automatically calculates the electronic attenuation. State and degree of attenuation are not available in that case.

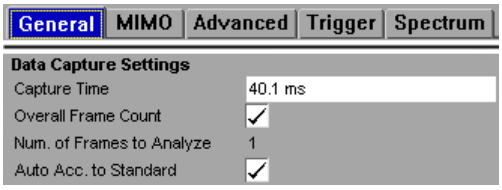
If you turn the electronic attenuator off, the degree of attenuation is not available.

SCPI command:
RF attenuation:
`INPut<n>:ATTenuation<analyzer>` on page 118
External attenuation:
`DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RLEVel:OFFSet` on page 118
Electronic attenuation:
`INPut<n>:EATT:STATe` on page 119
`INPut<n>:EATT:AUTO` on page 119
`INPut<n>:EATT` on page 119

6.2.3 Configuring the Data Capture

The data capture settings contain settings that control the amount of data and the way that the application records the LTE signal.

The data capture settings are part of the "General" tab of the "General Settings" dialog box.



Capture Time....54
Overall Frame Count....55
Number of Frames to Analyze....55
Auto According to Standard....55

Capture Time
Defines the capture time.

The capture time corresponds to the time of one sweep. Hence, it defines the amount of data the application captures during one sweep.

By default, the application captures 20.1 ms of data to make sure that at least one complete LTE frame is captured in one sweep.

SCPI command:
`[SENSe]:SWEep:TIME` on page 121

Overall Frame Count
Turns the manual selection of the number of frames to capture (and analyze) on and off.

If the overall frame count is active, you can define a particular number of frames to capture and analyze. The measurement runs until all required frames have been analyzed, even if it takes more than one sweep. The results are an average of the captured frames.

If the overall frame count is inactive, the R&S FSQ analyzes all complete LTE frames currently in the capture buffer.

SCPI command:
`[SENSe][:LTE]:FRAMe:COUNt:STATe` on page 121

Number of Frames to Analyze
Sets the number of frames that you want to capture and analyze.

If the number of frames you have set last longer than a single sweep, the R&S FSQ continues the measurement until all frames have been captured.

The parameter is read only if

- the overall frame count is inactive,
- the data is captured according to the standard.

SCPI command:
`[SENSe][:LTE]:FRAMe:COUNt` on page 120

Auto According to Standard
Turns automatic selection of the number of frames to capture and analyze on and off.

If active, the R&S FSQ evaluates the number of frames as defined for EVM tests in the LTE standard.

If inactive, you can set the number of frames you want to analyze.

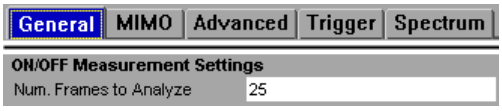
This parameter is not available if the overall frame count is inactive.

SCPI command:
`[SENSe][:LTE]:FRAMe:COUNt:AUTO` on page 120

6.2.4 Configuring On/Off Power Measurements

The On/Off power measurement settings define characteristics of On/Off power measurements.

The On/Off measurement settings are part of the "General" tab of the "General Settings" dialog box.



Number of Frames.....56

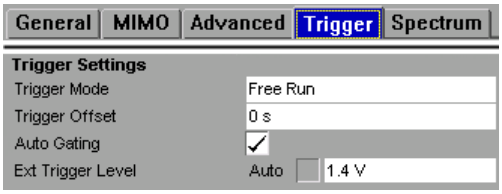
Number of Frames
Defines the number of frames that are averaged to calculate a reliable power trace for On/Off Power measurements.

SCPI command:
`CONFigure[:LTE]:OOPower:NFRames` on page 121

6.2.5 Triggering Measurements

The trigger settings contain settings that control triggered measurements.

The trigger settings are part of the "Trigger" tab of the "General Settings" dialog box.



For more information also see Auto Gating in the "Spectrum" tab of the "General Settings" dialog box.

Configuring the Trigger.....56

Configuring the Trigger
A trigger allows you to capture those parts of the signal that you are really interested in.

While the R&S FSQ runs freely and analyzes all signal data in its default state, no matter if the signal contains information or not, a trigger initiates a measurement only under certain circumstances (the trigger event).

The R&S FSQ supports several **trigger modes** or sources.

- Free Run
  Starts the measurement immediately and measures continuously.
- External
  The trigger event is the level of an external trigger signal. The measurement starts when this signal meets or exceeds a specified trigger level at the "Ext Trigger/Gate" input.
- IF Power
  The trigger event is the IF power level. The measurement starts when the IF power meets or exceeds a specified power trigger level.

You can define a **power level** for an external and an IF power trigger.

The name and contents of the Power Level field depend on the selected trigger mode. It is available only in combination with the corresponding trigger mode.

The measurement starts as soon as the trigger event happens. It may become necessary to start the measurement some time after the trigger event. In that case, define a **trigger offset** (or trigger delay). The trigger offset is the time that should pass between the trigger event and the start of the measurement.

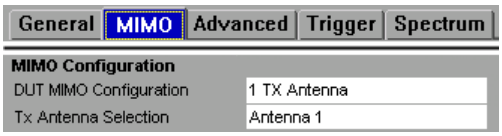
The trigger offset may be a negative time. The trigger offset is then called a **pretrigger**.

The trigger offset is available for all trigger modes, except free run.

SCPI command:
Trigger mode:
TRIGger[:SEQuence]:MODE on page 123
Trigger level:
TRIGger[:SEQuence]:LEVel<analyzer>:POWer on page 122
Trigger offset:
TRIGger[:SEQuence]:HOLDoff<analyzer> on page 122

6.3 Configuring MIMO Setups

The MIMO Configuration contains settings to configure MIMO test setups.



MIMO Configuration.....57

MIMO Configuration
Selects the antenna configuration and test conditions for a MIMO system.

The MIMO **configuration** selects the number of transmit antennas in the system. 1-, 2-, and 4-antenna configurations are possible.

In setups with multiple antennas, **antenna selection** defines the antenna you'd like to test. You can select the antenna(s) to test manually.

Antenna 1	Tests antenna 1 only.
Antenna 2	Tests antenna 2 only.
Antenna 3	Tests antenna 3 only.
Antenna 4	Tests antenna 4 only.

SCPI command:
MIMO configuration
CONFigure[:LTE]:DL:MIMO:CONFig on page 123
Antenna selection:
CONFigure[:LTE]:DL:MIMO:ASELection on page 123

6.4 Configuring Spectrum Measurements

The Spectrum settings contain parameters to configure spectrum measurements (ACLR and SEM) in particular.

6.4.1 Configuring SEM Measurements

The SEM settings are part of the "Spectrum" tab of the "General Settings" dialog box.

Category....58

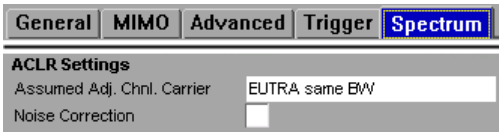
Category
Selects the limit definitions for SEM measurements.

Category A and B are defined in ITU-R recommendation SM.329. The category you should use for the measurement depends on the category that the base station you are testing supports.

SCPI command:
`[SENSe]:POWer:SEM:CATegory` on page 93

6.4.2 Configuring ACLR Measurements

The ACLR settings are part of the "Spectrum" tab of the "General Settings" dialog box.



Assumed Adjacent Channel Carrier....58
Noise Correction....58

Assumed Adjacent Channel Carrier
Selects the assumed adjacent channel carrier for the ACLR measurement.

The supported types are EUTRA of same bandwidth, 1.28 Mcps UTRA, 3.84 Mcps UTRA and 7.68 Mcps UTRA.

Note that not all combinations of LTE Channel Bandwidth settings and Assumed Adj. Channel Carrier settings are defined in the 3GPP standard.

SCPI command:
`[SENSe]:POWer:ACHannel:AACHannel` on page 92

Noise Correction
Turns noise correction on and off.

For more information see the manual of the R&S FSQ.

Note that the input attenuator makes a clicking noise after each sweep if you are using the noise correction in combination with the auto leveling process.

SCPI command:
`[SENSe]:POWer:NCORrection` on page 92

6.4.3 Configuring Gated Measurements

The gate settings settings are part of the "Spectrum" tab of the "General Settings" dialog box.

Auto Gating.....59

Auto Gating
Turns gating for SEM and ACLR measurements on and off.

If on, the software evaluates the on-periods of an LTE TDD signal only. The software determines the location and length of the on-period from the "TDD UL/DL Allocations" and the "Configuration of the Special Subframe".

Auto gating is available for TDD measurements in combination with an external or IF power trigger.

If you are using an external trigger, the DUT has to send an LTE frame trigger.

SCPI command:
`[SENSe]:SWEep:EGATe:AUTO` on page 93

6.5 Advanced General Settings

The "Advanced" settings contain parameters to configure more complex measurement setups.

6.5.1 Controlling I/Q Data

The I/Q settings contain settings that control the I/Q data flow.

The I/Q settings are part of the "Advanced Settings" tab of the "General Settings" dialog box.

Swap I/Q.....59

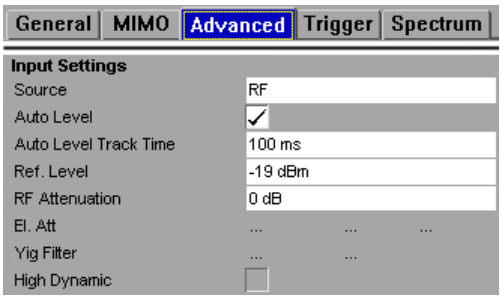
Swap I/Q
Swaps the real (I branch) and the imaginary (Q branch) parts of the signal.

SCPI command:
`[SENSe]:SWAPiq` on page 124

6.5.2 Controlling the Input

The input settings contain settings that control the input source.

The input settings are part of the "Advanced Settings" tab of the "General Settings" dialog box.



For more information on reference level see "Defining a Reference Level" on page 52.

For more information on signal attenuation see "Attenuating the Signal" on page 53.

Selecting the Input Source....60
Yig Filter....60
High Dynamic....61

Selecting the Input Source
The input source selects the source of the data you'd like to analyze. You can either analyze a live signal or a signal that has been recorded previously and whose characteristics have been saved to a file.

You can select the input source from the "Source" dropdown menu.

- RF
  Captures and analyzes the data from the RF input of the spectrum analyzer in use.
- Baseband (BB)
  Captures and analyzes the data from the baseband input of the spectrum analyzer in use.
  The analog baseband input is available with option R&S FSQ-B71.
- Digital I/Q
  Captures and analyzes the data from the digital baseband input of the spectrum analyzer in use.
  The digital baseband input is available with option R&S FSQ-B17.

For more information on using hardware options R&S FSQ-B17 and -B71 see the manual of the R&S FSQ.

SCPI command:
`INPut:SELect` on page 124

Yig Filter
Configures the YIG filter.

If you want to measure broadband signals, you can configure the YIG filter for a greater bandwidth.

The process of configuring the YIG filter consist of two steps.

- **Selecting the mode**
  You can select either manual or automatic control of the YIG filter.
- **Selecting the state**
  Turns the YIG filter on and off.
  If inactive, you can use the maximum bandwidth. However, image frequency rejection is no longer ensured.

If you have selected automatic YIG filter control, the R&S FSQ automatically resolves whether to use the YIG filter or not. Manual selection of the YIG filter state is not available in that case.

Note that the R&S FSQ uses the YIG filter only for frequencies greater than 3.6 GHz. If the frequency is smaller, these settings have no effect.

SCPI command:
`INPut<n>:FILTer:YIG[:STATe]` on page 125
`INPut<n>:FILTer:YIG:AUTO` on page 125

High Dynamic
Turns the bypass of the bandwidth extension R&S FSQ-B72 on and off if you are using a wideband filter. The signal instead passes through the normal signal path.

If active, high dynamic results in a higher resolution because the normal signal path uses a 14-bit ADC. However, all signals to the left or right of the spectrum of interest are folded into the spectrum itself.

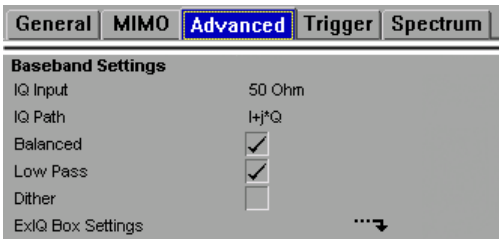
The high dynamic functionality is available only if R&S FSQ-B72 is installed and the sample rate is in the range from 20.4 MHz to 40.8 MHz.

SCPI command:
`TRACe:IQ:FILTer:FLATness` on page 125

6.5.3 Configuring the Baseband Input

The baseband settings contain settings that configure the baseband input.

The baseband settings are part of the "Advanced Settings" tab of the "General Settings" dialog box.



I/Q Input....62
I/Q Path....62
Balanced....62
Low Pass....62
Dither....62

I/Q Input
Selects the impedance of the baseband inputs.

Depending on the configuration of the baseband input, you can select an impedance of 50 Ω and 1 k Ω or 1 M Ω.

The I/Q input is available only if you have selected a baseband input source.

SCPI command:
`INPut:IQ:IMPedance` on page 126

I/Q Path
Selects the input path for baseband inputs.

You can either select a single input (I or Q) or a dual input (I and Q).

If you are using single input, swapping the I and Q branches becomes unavailable.

The I/Q path selection is available only if you have selected a baseband input source.

SCPI command:
`INPut:IQ:TYPE` on page 126

Balanced
Turns symmetric (or balanced) input on and off.

If active, a ground connection is not necessary. If you are using an assymetrical (unbalanced) setup, the ground connection runs through the shield of the coaxial cable that is used to connect the DUT

Balancing is available for a baseband input source.

SCPI command:
`INPut:IQ:BALanced[:STATe]` on page 125

Low Pass
Turns an anti-aliasing low pass filter on and off.

The filter has a cut-off frequency of 36 MHz and prevents frequencies above from being mixed into the usable frequency range. Note that if you turn the filter off, harmonics or spurious emissions of the DUT might be in the frequency range above 36 MHz and might be missed.

You can turn it off for measurement bandwidths greater than 30 MHz.

The low pass filter is available for a baseband input source.

SCPI command:
`[SENSe]:IQ:LPASs[:STATe]` on page 126

Dither
Adds a noise signal into the signal path of the baseband input.

Dithering improves the linearity of the A/D converter at low signal levels or low modulation. Improving the linearity also improves the accuracy of the displayed signal levels.

The signal has a bandwidth of 2 MHz with a center frequency of 38.93 MHz.

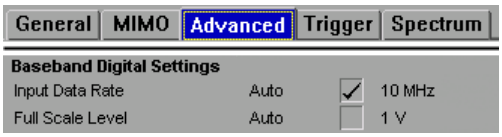
Dithering is available for a baseband input source.

SCPI command:
`[SENSe]:IQ:DITHer[:STATe]` on page 126

6.5.4 Configuring the Digital I/Q Input

The digital I/Q settings contain settings that configure the digital I/Q input.

The digital I/Q settings are part of the "Advanced Settings" tab of the "General Settings" dialog box.



Sampling Rate (Input Data Rate).....63
Full Scale Level.....63

Sampling Rate (Input Data Rate)
Defines the data sample rate at the digital baseband input.

The sample rate is available for a digital baseband input source.

SCPI command:
`INPut<n>:DIQ:SRATe` on page 127

Full Scale Level
Defines the voltage corresponding to the maximum input value of the digital baseband input.

SCPI command:
`INPut<n>:DIQ:RANGe[:UPPer]` on page 127

6.6 Configuring Downlink Signal Demodulation

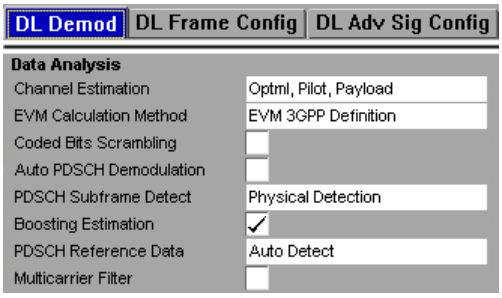
The downlink demodulation settings contain settings that describe the signal processing and the way the signal is measured.

You can find the demodulation settings in the "Demod Settings" dialog box.

6.6.1 Configuring the Data Analysis

The data analysis settings contain settings that determine the way the captured signal is analyzed.

The data analysis settings are part of the "Downlink Demod" tab of the "Demodulation Settings" dialog box.



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EVM Calculation Method....64
Scrambling of Coded Bits....64
Auto PDSCH Demodulation....65
PDSCH Subframe Configuration Detection....65
Boosting Estimation....66
PDSCH Reference Data....66
Multicarrier Filter....66

Channel Estimation
Selects the method of channel estimation.

- **EVM 3GPP Definition**
  Channel estimation according to 3GPP TS 36.141. This method is based on averaging in frequency direction and linear interpolation. Examines the reference signal only.
- **Optimal, Pilot only**
  Optimal channel estimation method. Examines the reference signal only.
- **Optimal, Pilot and Payload**
  Optimal channel estimation method. Examines both the reference signal and the payload resource elements.

SCPI command:
`[SENSe][:LTE]:DL:DEMod:CESTimation` on page 128

EVM Calculation Method
Selects the method to calculate the EVM.

- **EVM 3GPP Definition**
  Calculation of the EVM according to 3GPP TS 36.141. Evaluates the EVM at two trial timing positions and then uses the maximum EVM of the two.
- **At Optimal Timing Position**
  Calculates the EVM using the optimal timing position.

SCPI command:
`[SENSe][:LTE]:DL:DEMod:EVMCalc` on page 129

Scrambling of Coded Bits
Turns the scrambling of coded bits for all physical channels like PDSCH or PHICH on and off.

The scrambling of coded bits affects the bitstream results.

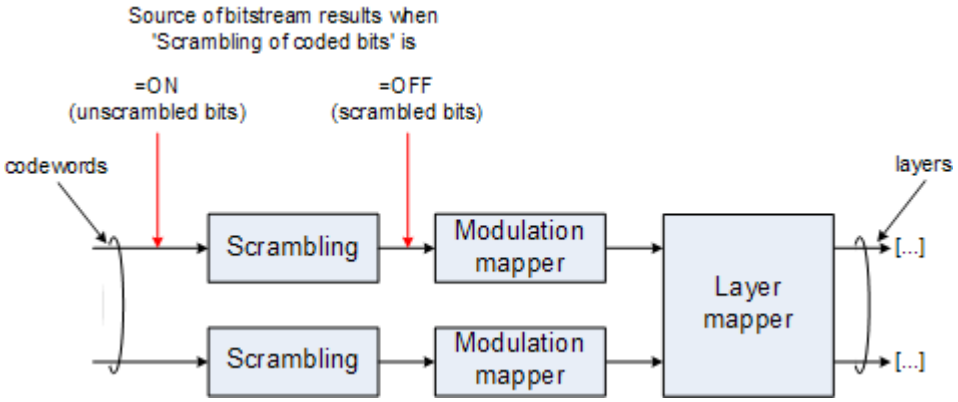


Fig. 6-1: Source for bitstream results if scrambling for coded bits is on and off

SCPI command:
`[SENSe][:LTE]:DL:DEMod:CBSCrambling` on page 128

Auto PDSCH Demodulation
Turns automatic demodulation of the PDSCH on and off.

Turn on automatic PDSCH demodulation for automatic detection of the PDSCH resource allocation. The application is able to detect the PDSCH resource allocation by analyzing the protocol information in the PDCCH or by analyzing the physical signal. It then writes the results into the PDSCH Configuration Table.

You can set the way the R&S FSQ identifies the PDSCH resource allocation with "PDSCH Subframe Configuration Detection" on page 65.

If the automatic demodulation of the PDSCH is off, you have to configure the PDSCH manually. In that case, the application compares the demodulated LTE frame to the customized configuration. If the PDSCH Subframe Configuration Detection is not turned off, the application analyzes the frame only if both configurations are the same.

SCPI command:
`[SENSe][:LTE]:DL:DEMod:AUTO` on page 128

PDSCH Subframe Configuration Detection
Selects the method of identifying the PDSCH resource allocation.

- Off
  Uses the user configuration to demodulate the PDSCH subframe. If the user configuration does not match the frame that was measured, a bad EVM will result.
- PDCCH protocol
  Sets the PDSCH configuration according to the data in the protocol of the PDCCH DCIs.
- Physical detection
  Physical detection makes measurements on TDD E-TMs without a 20 ms trigger signal possible.

The "PDSCH Subframe Configuration Detection" is not available if you have turned on Auto PDSCH Demodulation.

SCPI command:
`[SENSe][:LTE]:DL:FORMat:PSCD` on page 129

Boosting Estimation
Turns boosting estimation on and off.

If active, the R&S FSQ automatically sets the relative power settings of all physical channels and the P-/S-SYNC by analyzing the signal.

SCPI command:
`[SENSe][:LTE]:DL:DEMod:BESTimation` on page 128

PDSCH Reference Data
Selects the type of reference data to calculate the EVM for the PDSCH.

- Auto detect
  Automatically identifies the reference data for the PDSCH by analyzing the signal.
- All 0 (E-TM)
  Sets the PDSCH reference data to a fixed value of 0. This value is according to the test model definition.
  To get valid results, you have to use a DUT that transmits an all-zero data vector. This setting is a good way if you are expecting signals with a high EVM because the automatic detection will not be reliable in that case.

SCPI command:
`[SENSe][:LTE]:DL:DEMod:PRData` on page 129

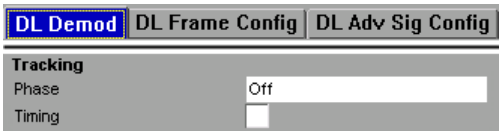
Multicarrier Filter
Turns the suppression of interference of neighboring carriers for tests on multiradio base stations on and off (e.g. LTE, WCDMA, GSM etc).

SCPI command:
`[SENSe][:LTE]:DL:DEMod:MCFilter` on page 129

6.6.2 Compensating Measurement Errors

The tracking settings contain settings that compensate for various common measurement errors that may occur.

The tracking settings are part of the "Downlink Demod" tab of the "Demodulation Settings" dialog box.



Phase....66
Timing....67

Phase
Specifies whether or not the measurement results should be compensated for common phase error. When phase compensation is used, the measurement results will be compensated for phase error on a per-symbol basis.

"Off" Phase tracking is not applied.

"Pilot Only" Only the reference signal is used for the estimation of the phase error.

"Pilot and Payload" Both reference signal and payload resource elements are used for the estimation of the phase error.

SCPI command:
`[SENSe][:LTE]:DL:TRACking:PHASe` on page 130

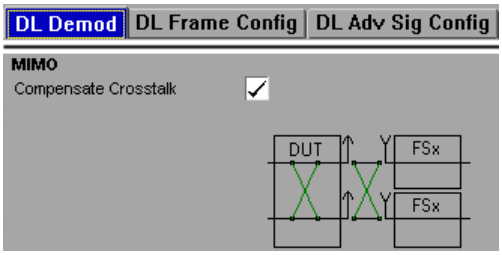
Timing
Specifies whether or not the measurement results should be compensated for timing error. When timing compensation is used, the measurement results will be compensated for timing error on a per-symbol basis.

SCPI command:
`[SENSe][:LTE]:DL:TRACking:TIME` on page 130

6.6.3 Configuring MIMO Setups

The MIMO settings contain settings that configure MIMO measurement setups.

The MIMO settings are part of the "Downlink Demod" tab of the "Demodulation Settings" dialog box.



Compensate Crosstalk.....67

Compensate Crosstalk
Specifies if crosstalk produced by the device under test or over-the-air measurements will be compensated or not.

SCPI command:
`CONFigure[:LTE]:DL:MIMO:CROSstalk` on page 131

6.7 Configuring Downlink Frames

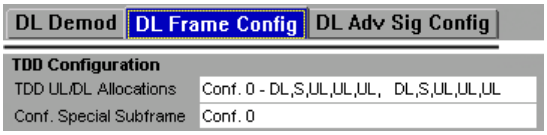
The frame configuration contains settings that define the structure of the downlink LTE signal.

You can find the frame structure in the "Demod Settings" dialog box.

6.7.1 Configuring TDD Signals

The TDD settings define the characteristics of an LTE TDD signal.

The TDD settings are part of the "Frame Configuration" tab of the "Demodulation Settings" dialog box.



Configuring TDD Frames.....68

Configuring TDD Frames

TDD frames contain both uplink and downlink information separated in time with every subframe being responsible for either uplink or downlink transmission. The standard specifies several subframe configurations or resource allocations for TDD systems.

TDD UL/DL Allocations

Selects the configuration of the subframes in a radio frame in TDD systems.

The UL/DL configuration (or allocation) defines the way each subframe is used: for uplink, downlink or if it is a special subframe. The standard specifies seven different configurations.

Configuration	Subframe Number and Usage									
	0	1	2	3	4	5	6	7	8	9
0	D	S	U	U	U	D	S	U	U	U
1	D	S	U	U	D	D	S	U	U	D
2	D	S	U	D	D	D	S	U	D	D
3	D	S	U	U	U	D	D	D	D	D
4	D	S	U	U	D	D	D	D	D	D
5	D	S	U	D	D	D	D	D	D	D
6	D	S	U	U	U	D	S	U	U	D

U = uplink
D = downlink
S = special subframe

Conf. of Special Subframe

In combination with the cyclic prefix, the special subframes serve as guard periods for switches from uplink to downlink. They contain three parts or fields.

- DwPTS
  The DwPTS is the downlink part of the special subframe. It is used to transmit downlink data.
- GP
  The guard period makes sure that there are no overlaps of up- and downlink signals during a switch.
- UpPTS
  The UpPTS is the uplink part of the special subframe. It is used to transmit uplink data.

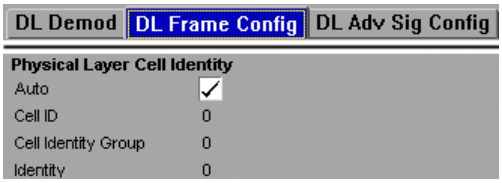
The length of the three fields is variable. This results in several possible configurations of the special subframe. The LTE standard defines 9 different configurations for the special subframe. However, configurations 7 and 8 only work for a normal cyclic prefix. If you select it using an extended cyclic prefix or automatic detection of the cyclic prefix, the application will show an error message.

SCPI command:
Subframe
`CONFigure[:LTE]:DL:TDD:UDConf` on page 131
Special Subframe
`CONFigure[:LTE]:DL:TDD:SPSC` on page 131

6.7.2 Configuring the Physical Layer Cell Identity

The physical signal characteristics contain settings to describe the phyiscal attributes of an LTE signal.

The physical settings are part of the "Frame Configuration" tab of the "Demodulation Settings" dialog box.



Configuring the Physical Layer Cell Identity.....69

Configuring the Physical Layer Cell Identity
The cell ID, cell identity group and physical layer identity are interdependent parameters. In combination they are responsible for synchronization between network and user equipment.

The physical layer cell ID identifies a particular radio cell in the LTE network. The cell identities are divided into 168 unique cell identity groups. Each group consists of 3 physical layer identities. According to

$$N_{ID}^{cell} = 3 \cdot N_{ID}^{(1)} + N_{ID}^{(2)}$$

$N^{(1)}$ = cell identity group, {0...167}
$N^{(2)}$ = physical layer identity, {0...2}

there is a total of 504 different cell IDs.

If you change one of these three parameters, the R&S FSQ automatically updates the other two.

For automatic detection of the cell ID, turn the "Auto" function on.

Before it can establish a connection, the user equipment must synchronize to the radio cell it is in. For this purpose, two synchronization signals are transmitted on the downlink. These two signals are reference signals whose content is defined by the "Physical Layer Identity" and the "Cell Identity Group".

The first signal is one of 3 possible Zadoff-Chu sequences. The sequence that is used is defined by the physical layer identity. It is contained in the P-SYNC.

The second signal is one of 168 unique sequences. The sequence is defined by the cell identity group. This sequence is contained in the S-SYNC.

In addition to the synchronization information, the cell ID also determines

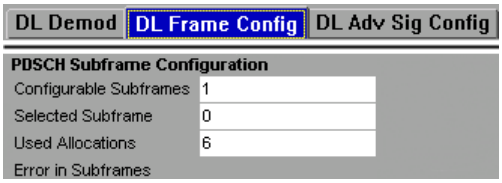
- the cyclic shifts for PCFICH, PHICH and PDCCH mapping,
- the frequency shifts of the reference signal.

SCPI command:
Cell Identity Group:
`CONFigure[:LTE]:DL:PLC:CIDGroup` on page 132
`FETCh:PLC:CIDGroup?` on page 96
Identity
`CONFigure[:LTE]:DL:PLC:PLID` on page 132
`FETCh:PLC:PLID?` on page 97

6.7.3 Configuring PDSCH Subframes

The application allows you to configure individual subframes that are used to carry the information of the PDSCH. The PDSCH (Physical Downlink Shared Channel) primarily carries all general user data. It therefore takes up most of the space in a radio frame.

If you turn "Auto Demodulation" on, the appplication automatically determines the subframe configuration for the PDSCH. In the default state, automatic configuration is on.



Every LTE frame (FDD and TDD) contains 10 subframes. Each downlink subframe consists of one or more (resource) allocations. The R&S FSQ shows the contents for each subframe in the configuration table. In the configuration table, each row corresponds to one allocation.

ID / N_RNTI	Code Word	Modulation	Number of RB	Offset RB	Rho A (Power)/dB	Confl.
0	1/1	QPSK	4	6	0 dB	
1	1/1	QPSK	2	10	0 dB	
2	1/1	QPSK	4	0	0 dB	
3	1/1	QPSK	2	5	0 dB	
4	1/1	QPSK	2	12	0 dB	
5	1/1	QPSK	1	14	0 dB	

If there are any errors or conflicts between allocations in one or more subframes, the application shows the number of errors and the number of the corrupt subframe in the "Error in Subframes" field. It does not show the kind of error.

Before you start to work on the contents of each subframe, you should define the number of subframes you want to customize with the "Configurable Subframes" parameter. The application supports the configuration of up to 40 subframes.

Then you can select a particular subframe that you want to customize in the "Selected Subframe" field. Enter the number of the subframe (starting with 0). The application updates the contents of the configuration table to the selected subframe.

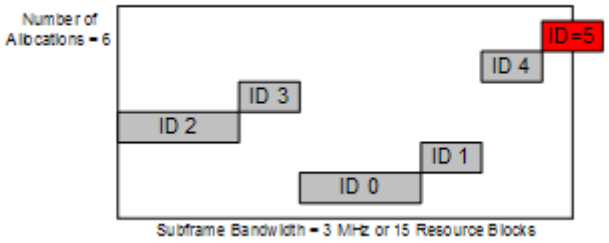
Configuring PDSCH Allocations.....71

Configuring PDSCH Allocations

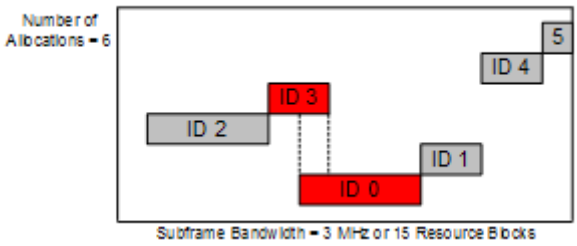
In the default state, each subframe contains one allocation. Add allocations with the "Used Allocations" parameter. The application expands the configuration table accordingly with one row representing one allocation. You can define a different number of allocations for each subframe you want to configure and configure up to 110 allocations in every subframe.

The configuration table contains the settings to configure the allocations.

- ID/N_RNTI
  Selects the allocation's ID. The ID corresponds to the N_RNTI.
  By default, the application assigns consecutive numbers starting with 0.
  The ID, or N_RNTI, is the user equipment identifier for the corresponding allocation and is a number in the range from 0 to 65535. The order of the numbers is irrelevant.
  You can combine allocations by assigning the same number more than once. Combining allocations assigns those allocations to the same user. Allocations with the same N_RNTI share the same modulation scheme and power settings.
- Code Word
  Shows the code word of the allocation.
  The code word is made up out of two numbers. The first number is the number of the code word in the allocation. The second number is the total number of code words that the allocation includes. Thus, a table entry of "1/2" would mean that the row corresponds to code word 1 out of 2 code words in the allocation.
- Modulation
  Selects the modulation scheme for the corresponding allocation.
  The modulation scheme for the PDSCH is either QPSK, 16QAM or 64QAM.
- Number of RB
  Defines the number of resource blocks the allocation covers. The number of resource blocks defines the size or bandwidth of the allocation.
  If you allocate too many resource blocks compared to the bandwidth you have set, the R&S FSQ will show an error message in the "Conflicts" column and the "Error in Subframes" field.
- Offset RB
  Sets the resource block at which the allocation begins.
  A wrong offset for any allocation would lead to an overlap of allocations. In that case the application will show an error message.
- Power [dB]
  Sets the boosting of the allocation. Boosting is the allocation's power relative to the reference signal power.
- Conflict
  In case of a conflict, the application shows the type of conflict and the ID of the allocations that are affected. Possible conflicts are:
  – bandwidth error (">BW")
    A bandwidth error occurs when the number of resource blocks in the subframe exceeds the bandwidth you have set.



– RB overlap errors
An RB overlap error occurs if one or more allocations overlap. In that case, check if the length and offset values of the allocations are correct.



SCPI command:
Configurable Subframes:
`CONFigure[:LTE]:DL:CSUBframes` on page 133
Used Allocations:
`CONFigure[:LTE]:DL:SUBFrame<subframe>:ALCount` on page 134
Modulation:
`CONFigure[:LTE]:DL:SUBFrame<subframe>:ALLoc<allocation>[:CW<Cwnum>]:MODulation` on page 134
Number of RB:
`CONFigure[:LTE]:DL:SUBFrame<subframe>:ALLoc<allocation>:RBCount` on page 135
Offset RB:
`CONFigure[:LTE]:DL:SUBFrame<subframe>:ALLoc<allocation>:RBOFfset` on page 135
Power:
`CONFigure[:LTE]:DL:SUBFrame<subframe>:ALLoc<allocation>:POWer` on page 134

6.8 Defining Advanced Signal Characteristics

The downlink advanced signal characteristics contain settings that describe the detailed structure of a downlink LTE signal.

You can find the advanced signal characteristics in the "Demod Settings" dialog box.

6.8.1 Defining the PDSCH Resource Block Symbol Offset

The PDSCH Resource Block (PRB) symbol offset is part of the global settings in the "Downlink Adv Sig Config" tab of the "Demodulation Settings" dialog box.

PRB Symbol Offset.....73

PRB Symbol Offset
PRB Symbol Offset specifies the symbol offset of the PDSCH allocations relative to the subframe start. This setting applies to all subframes in a frame.

With this settings, the number of OFDM symbols used for control channels is defined, too. For example, if this parameter is set to 2 and the PDCCH is enabled, the number of OFDM symbols actually used by the PDCCH is 2.

Special control channels like the PCFICH or PHICH require a minimum number of control channel OFDM symbols at the beginning of each subframe. If PRB Symbol Offset is lower than the required value, the control channel data overwrites some resource elements of the PDSCH.

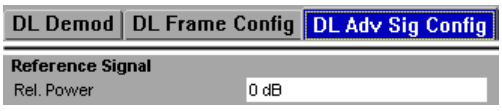
If Auto is selected, the Control Region for PDCCH (PRB Symbol Offset) value is detected from the PCFICH. For correct Demodulation of a 3GPP conform PCFICH signal, the Scrambling of Coded Bits has to be enabled.

SCPI command:
`CONFigure[:LTE]:DL:PSOFfset` on page 135

6.8.2 Configuring the Reference Signal

The reference signal settings contain settings to describe the physical attributes and structure of the reference signal.

The reference signal settings are part of the "Downlink Adv Sig Config" tab of the "Demodulation Settings" dialog box.



Rel Power (Reference Signal).....73

Rel Power (Reference Signal)
Defines the relative power of the reference signal compared to all the other physical signals and physical channels.

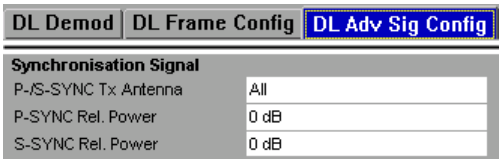
Note that this setting gives you an offset to all other relative power settings.

SCPI command:
`CONFigure[:LTE]:DL:REFSig:POWer` on page 136

6.8.3 Configuring the Synchronization Signal

The synchronization signal settings contain settings to describe the physical attributes and structure of the synchronization signal.

The synchronization signal settings are part of the "Downlink Adv Sig Config" tab of the "Demodulation Settings" dialog box.



P-/S-SYNC Tx Antenna....74
P-SYNC Relative Power....74
S-SYNC Relative Power....74

P-/S-SYNC Tx Antenna
Selects the antenna that transmits the P-SYNC and the S-SYNC.

When selecting the antenna, you implicitly select the synchronization method. If the selected antenna transmits no synchronization signal, the application uses the reference signal to synchronize. Note that automatic cell ID detection is not available if synchronization is based on the reference signal.

SCPI command:
`CONFigure[:LTE]:DL:SYNC:ANTenna` on page 136

P-SYNC Relative Power
Defines the power of the P-SYNC signals relative to the reference signal.

SCPI command:
`CONFigure[:LTE]:DL:SYNC:PPOWer` on page 136

S-SYNC Relative Power
Defines the power of the S-SYNC signals relative to the reference signal.

SCPI command:
`CONFigure[:LTE]:DL:SYNC:SPOWer` on page 136

6.8.4 Configuring the Control Channels

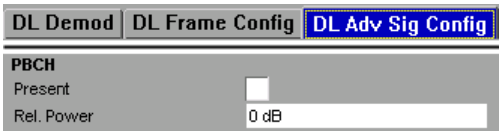
The control channel settings contain setting that describe the physical attributes and structure of the control channel.

The control channel settings are part of the "Downlink Signal Characteristics" tab of the "Demodulation Settings" dialog box.

- Configuring the PBCH....75
- Configuring the PCFICH....75
- Configuring the PHICH....75
- Configuring the PDCCH....77

6.8.4.1 Configuring the PBCH

The physical broadcast channel (PBCH) carries system information for the user equipment. You can include or exclude the PBCH in the test setup and define the relative power of this channel.



PBCH Present
Includes or excludes the PBCH from the test setup.

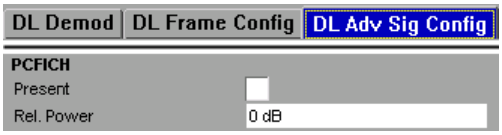
SCPI command:
`CONFigure[:LTE]:DL:PBCH:STAT` on page 137

PBCH Relative Power
Defines the power of the PBCH relative to the reference signal.

SCPI command:
`CONFigure[:LTE]:DL:PBCH:POWer` on page 137

6.8.4.2 Configuring the PCFICH

The physical control format indicator channel (PCFICH) carries information about the format of the PDCCH. You can include or exclude the PCFICH in the test setup and define the relative power of this channel.



PCFICH Present
Includes or excludes the PCFICH from the test setup.

SCPI command:
`CONFigure[:LTE]:DL:PCFich:STAT` on page 138

PCFICH Relative Power
Defines the power of the PCFICH relative to the reference signal.

SCPI command:
`CONFigure[:LTE]:DL:PCFich:POWer` on page 137

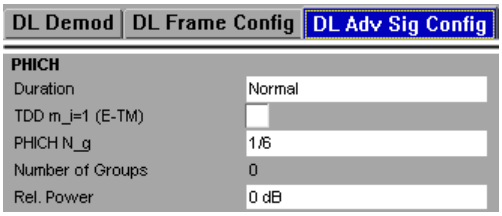
6.8.4.3 Configuring the PHICH

The physical hybrid ARQ indicator channel (PHICH) contains the hybrid ARQ indicator. The hybrid ARQ indicator contains the acknowledgement / negative acknowledgments for uplink blocks.

You can set several specific parameters for the PHICH.

Turning off the PHICH

If you set the value of the PHICH N_g to Custom and at the same time define "0" PHICH groups, the PHICH is excluded from the signal.



PHICH Duration

Selects the duration of the PHICH. Normal and extended duration are supported.

With a normal duration, all resource element groups of the PHICH are allocated on the first OFDM symbol.

With an extended duration, the resource element groups of the PHICH are distributed over three OFDM symbols for a normal subframe or over two symbols within a special subframe.

If you select Auto, the duration of PHICH is automatically determined and based on the PBCH decoding results.

Note that you have to turn on the PBCH for an automatic detetemination of the PHICH duration.

SCPI command:

`CONFigure[:LTE]:DL:PHICh:DURation` on page 139

PHICH TDD m_i=1 (E-TM)

Turns the special setting of the PHICH for the enhanced test models on and off.

The special setting is defined in 36.141 V9.0.0, 6.1.2.6: "For frame structure type 2 the factor m_i shall not be set as per TS36.211, Table 6.9-1, but instead shall be set to m_i=1 for all transmitted subframes."

The parameter is available if you have selected TDD.

SCPI command:

`CONFigure[:LTE]:DL:PHICh:MITM` on page 139

PHICH N_g

Sets the variable N_g.

N_g in combination with the number of resource blocks defines the number of PHICH groups in a downlink subframe. The standard specifies several values for N_g that you can select from the dropdown menu.

If you need a customized configuration, you can set the number of PHICH groups in a subframe by selecting the "Custom" menu item and set a number of PHICH groups directly with PHICH Number of Groups.

SCPI command:

`CONFigure[:LTE]:DL:PHICh:NGParameter` on page 139

PHICH Number of Groups
Sets the number of PHICH groups contained in a subframe.

To select a number of groups, you have to set the PHICH N_g to "Custom".

SCPI command:
`CONFigure[:LTE]:DL:PHICh:NOGRoups` on page 140

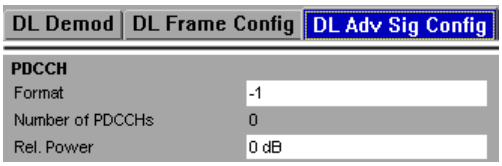
PHICH Rel Power
Defines the power of the PHICH relative to the reference signal.

SCPI command:
`CONFigure[:LTE]:DL:PHICh:POWer` on page 140

6.8.4.4 Configuring the PDCCH

The physical downlink control channel (PDCCH) carries the downlink control information.

The PDCCH is always present. You can define several specific parameters for the PDCCH.



PDCCH Format
Defines the format of the PDCCH (physical downlink control channel).

Note that PDCCH format "-1" is not defined in the standard. This format corresponds to the transmission of one PDCCH on all available resource element groups. As a special case for this PDCCH format, the center of the constellation diagram is treated as a valid constellation point.

SCPI command:
`CONFigure[:LTE]:DL:PDCCh:FORMat` on page 138

Number of PDCCHs
Sets the number of physical downlink control channels.

This parameter is available if the PDCCH format is -1.

SCPI command:
`CONFigure[:LTE]:DL:PDCCh:NOPD` on page 138

PDCCH Rel Power
Defines the power of the PDCCH relative to the reference signal.

SCPI command:
`CONFigure[:LTE]:DL:PDCCh:POWer` on page 138

7 Analyzing Measurement Results

The "Measurement Settings" contain settings that configure various result displays. These settings are independent of the signal, they adjust the display of the results. You can open the dialog box with the "Meas Settings" softkey. The corresponding dialog box is made up of three tabs. By default, the "Selection" tab is the active one.

- Selecting a Particular Signal Aspect....78
- Defining Measurement Units....79
- Defining Various Measurement Parameters....79
- Selecting the Contents of a Constellation Diagram....80
- Scaling the Y-Axis....81
- Using the Marker....82

7.1 Selecting a Particular Signal Aspect

In the "Selection" tab of the "Measurement Settings" dialog box you can select specific parts of the signal you want to analyze.

Subframe Selection
Selects a particular subframe whose results the software displays.

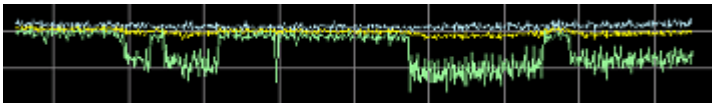
You can select a particular subframe for the following measurements.

Result Summary, EVM vs. Carrier, EVM vs. Symbol, Channel Flatness, Channel Group Delay, Channel Flatness Difference, Constellation Diagram, Allocation Summary and Bit Stream. If ---All--- is selected, either the results from all subframes are displayed at once or a statistic is calculated over all analyzed subframes.

Selecting "All" either displays the results over all subframes or calculates a statistic over all subframes that have been analyzed.

Example: Subframe selection

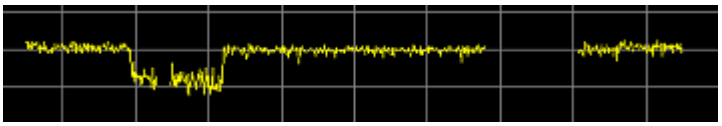
If you select all subframes ("All"), the application shows three traces. One trace shows the subframe with the minimum level characteristics, the second trace shows the subframe with the maximum level characteristics and the third subframe shows the averaged level characteristics of all subframes.



with AV MI PK

- PK: peak value
- AV: average value
- MI: minimum value

If you select a specific subframe, the application shows one trace. This trace contains the results for that subframe only.



SCPI command:
`[SENSe][:LTE]:SUBFrame:SELect` on page 141

7.2 Defining Measurement Units

In the "Units" tab of the "Measurement Settings" dialog box you can select the unit for various measurement results.

EVM Unit
Selects the unit for graphic and numerical EVM measurement results.

Possible units are dB and %.

SCPI command:
`UNIT:EVM` on page 141

7.3 Defining Various Measurement Parameters

In the "Misc" tab of the "Measurement Settings" dialog box you can set various parameters that affect some result displays.

Bit Stream Format
Selects the way the bit stream is displayed.

The bit stream is either a stream of raw bits or of symbols. In case of the symbol format, the bits that belong to a symbol are shown as hexadecimal numbers with two digits.

Examples:

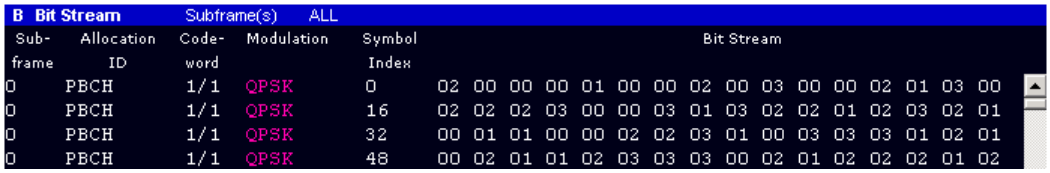


Fig. 7-1: Bit stream display in downlink application if the bit stream format is set to "symbols"

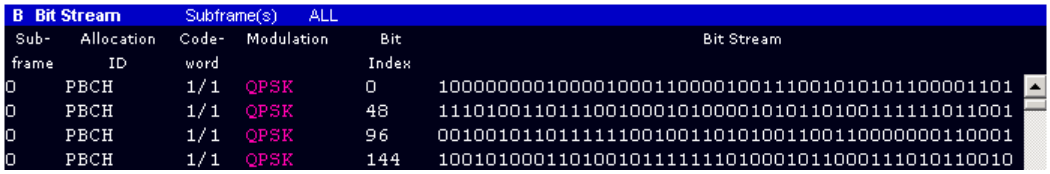


Fig. 7-2: Bit stream display in downlink application if the bit stream format is set to "bits"

SCPI command:
UNIT:BSTR on page 141

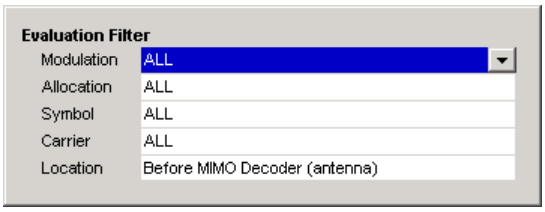
7.4 Selecting the Contents of a Constellation Diagram

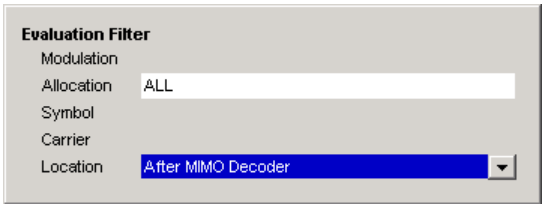
The "Evaluation Filter" dialog box contains settings to configure the contents of a constellation diagram.

You can access the dialog box with the "Constellation Selection" softkey in the "Measurement" menu.

Constellation Selection
Filters the displayed results. You can filter the results by any combination of modulation, allocation ID, symbol, carrier or location. The results are updated as soon as any change to the constellation selection parameters is made.

Note that the constellation selection is applied to all windows in split screen mode if the windows contain constellation diagrams.





You can filter the results by the following parameters:

- **Modulation**

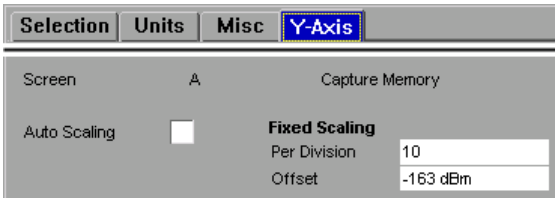
Filter by modulation scheme.

- **Allocation**
  Filter by allocation ID.
- **Symbol**
  Filter by OFDM symbol.
- **Carrier**
  Filter by subcarrier.
- **Location**
  Selects whether the R&S FSQ generates the constellation diagram before or after the MIMO decoder.
  If you use Spatial Multiplexing, symbols of different encoding schemes are merged in the MIMO encoder. Thus you get a mix of different modulation alphabets. Filter these symbols in the field "Modulation" with the value "MIXTURE". You get the mixed symbols only if "Location" is set to "Before MIMO decoder".
  If the location is "After MIMO Decoder", filters "Symbol" and "Carrier" are not available.

SCPI command:
Location:
`CONFigure[:LTE]:DL:CONS:LOCation` on page 140

7.5 Scaling the Y-Axis

In the "Y-Axis" tab of the "Measurement Settings" dialog box you can set various parameters that affect some result displays.



Y-Axis Scale
The y-axis scaling determines the vertical resolution of the measurement results. The scaling you select always applies to the currently active screen and the corresponding result display.

Usually, the best way to view the results is if they fit ideally in the diagram area in order to view the complete trace. This is the way the application scales the y-axis if you have turned on **automatic scaling**.

But it may become necessary to see a more detailed version of the results. In that case, turn on fixed scaling for the y-axis. **Fixed scaling** becomes available when you turn off automatic scaling. For a fixed scaling, define the distance between two grid lines (scaling **per division**) and the point of origin of the y-axis (the **offset**).

SCPI command:
Automatic scaling:
`DISPlay[:WINDow]:TRACe:Y:SCALe:AUTO` on page 144
Manual scaling:
`DISPlay[:WINDow]:TRACe:Y:SCALe:FIXScale:OFFSet` on page 144
`DISPlay[:WINDow]:TRACe:Y:SCALe:FIXScale:PERDiv` on page 144

7.6 Using the Marker

The firmware application provides a marker to work with. You can use a marker to mark specific points on traces or to read out measurement results.

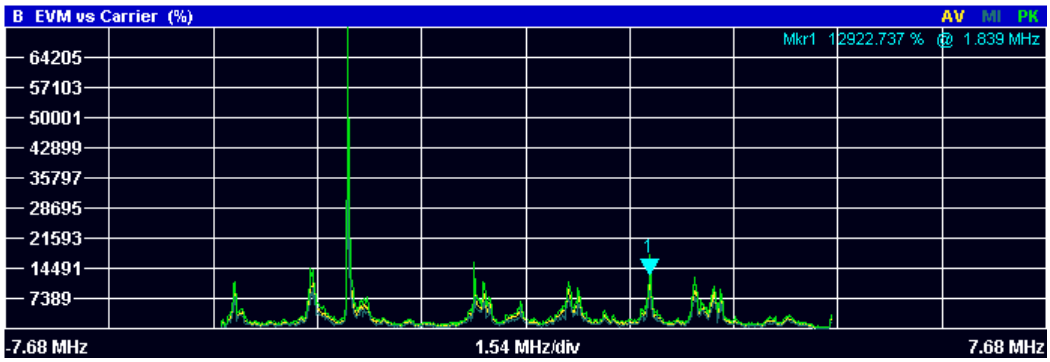


Fig. 7-3: Example: Marker

The MKR key opens the corresponding submenu. You can activate the marker with the "Marker 1" softkey. After pressing the "Marker 1" softkey, you can set the position of the marker in the marker dialog box by entering a frequency value. You can also shift the marker position by turning the rotary knob. The current marker frequency and the corresponding level is displayed in the upper right corner of the trace display.

The "Marker 1" softkey has three possible states:

If the "Marker 1" softkey is grey, the marker is off.

After pressing the "Marker 1" softkey it turns red to indicate an open dialog box and the the marker is active. The dialog box to specify the marker position on the frequency axis opens.

After closing the dialog box, the "Marker 1" softkey turns green. The marker stays active.

Pressing the "Marker 1" softkey again deactivates the marker. You can also turn off the marker by pressing the "Marker Off" softkey.

If you'd like to see the area of the spectrum around the marker in more detail, you can use the Marker Zoom function. Press the "Marker Zoom" softkey to open a dialog box in which you can specify the zoom factor. The maximum possible zoom factor depends on the result display. The "Unzoom" softkey cancels the marker zoom.

Note that the zoom function is not available for all result displays.

If you have more than one active trace, it is possible to assign the marker to a specific trace. Press the "Marker -> Trace" softkey in the marker to menu and specify the trace in the corresponding dialog box.

`CALCulate<n>:MARKer<m>[:STATe]` on page 142

`CALCulate<n>:MARKer<m>:AOFF` on page 142

`CALCulate<n>:MARKer<m>:TRACe` on page 142

`CALCulate<n>:MARKer<m>:X` on page 142

`CALCulate<n>:MARKer<m>:Y?` on page 143

8 File Management

8.1 File Manager

The root menu of the application includes a File Manager with limited functions for quick access to file management functionality.

Loading a Frame Setup

The frame setup or frame description describes the complete modulation structure of the signal, such as bandwidth, modulation, etc.

The frame setup is stored as an XML file. XML files are very commonly used to describe hierarchical structures in an easy-to-read format for both humans and PC.

A typical frame setup file would look like this:

```
<FrameDefinition LinkDirection="downlink" TDDULDLAllocationConfiguration="0"
RessourceBlocks="50" CP="auto" RefSigSubcarrierOffset="Auto" PSYNCBoostingdB="0"
SSYNCBoostingdB="0" ReferenceSignalBoostingdB="0" PBCHSymbolOffset="7" PBCHLength="4"
PCFICHIsPresent="false" PHICHNumGroups="0" PHICHDuration="Normal" PHICHBoostingdB="0"
PDCCHIsPresent="false" PSSYNCRepetitionPeriod="10" DataSymbolOffsetSubFrame="2"
MIMOConfiguration="1 Tx Antenna" MIMOAntennaSelection="Antenna 1" PhysLayCellIDGrp="Auto"
PhysLayID="Auto" RefSignal3GPPVersion="2" N_c_fastforward="0">
 <Frame>
  <Subframe>
   <PRBs>
    <PRB Start="0" Length="6" Boosting="0" Modulation="QPSK"/>
   </PRBs>
  </Subframe>
 </Frame>
 <stControl PhaseTracking="1" TimingTracking="0" ChannelEstimation="1"
  EVMCCalculationMethod="1" EnableScrambling="1" AutoDemodulation="1"/>
</FrameDefinition>
```

All settings that are available in the "Demod Settings" dialog box are also in the frame setup file. You can enter additional allocations by adding additional PRB entries in the PRBs list.

Note that at least one PRB must exist.

To load a frame setup, press the "File Manager" softkey in the root menu of the application. Select the file you want to load and activate it with the "Load Demod Setup" button.

Loading an I/Q File

The R&S FSQ is able to process I/Q data that has been captured with a R&S FSQ directly as well as data stored in a file. You can store I/Q data in various file formats in order to be able to process it with other external tools or for support purposes.

I/Q data can be formatted either in binary form or as ASCII files. The data is linearly scaled using the unit Volt (e.g. if a correct display of Capture Buffer power is required). For **binary** format, data is expected as 32-bit floating point data, Little Endian format (also known as LSB Order or Intel format). An example for binary data would be: 0x1D86E7BB in hexadecimal notation is decoded to -7.0655481E-3. The order of the data is either IQIQIQ or II...IQQ...Q.

For ASCII format, data is expected as I and Q values in alternating rows, separated by new lines: <I value 1>, <Q value 1>, <I value 2>, <Q value 2>, ...

To use data that has been stored externally, press the "File Manager" softkey in the root menu of the application. Select the file you want to load and activate it with the "Load IQ Data" button.

8.2 SAVE/RECALL Key

Besides the file manager in the root menu, you can also manage the data via the SAVE/RECALL key.

The corresponding menu offers full functionality for saving, restoring and managing the files on the R&S FSQ. The save/recall menu is the same as that of the spectrum mode. For details on the softkeys and handling of this file manager, refer to the operating manual of the R&S FSQ.

9 Remote Commands

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9.1 Overview of Remote Command Suffixes

This chapter provides an overview of all suffixes used for remote commands in the LTE application.

Suffix	Description
<allocation>	Selects an allocation.
<analyzer>	No effect.
<antenna>	Selects an antenna for MIMO measurements.
<cluster>	Selects a cluster (uplink only).
<cwnum>	Selects a codeword.
<k>	Selects a limit line. Irrelevant for the LTE application.
<m>	Selects a marker. Irrelevant for the LTE application.
<n>	Selects a measurement window.
<subframe>	Selects a subframe.
<t>	Selects a trace. Irrelevant for the LTE application.

9.2 Introduction

Commands are program messages that a controller (e.g. a PC) sends to the instrument or software. They operate its functions ('setting commands' or 'events') and request information ('query commands'). Some commands can only be used in one way, others work in two ways (setting and query). If not indicated otherwise, the commands can be used for settings and queries.

The syntax of a SCPI command consists of a header and, in most cases, one or more parameters. To use a command as a query, you have to append a question mark after the last header element, even if the command contains a parameter.

A header contains one or more keywords, separated by a colon. Header and parameters are separated by a "white space" (ASCII code 0 to 9, 11 to 32 decimal, e.g. blank). If there is more than one parameter for a command, these are separated by a comma from one another.

Only the most important characteristics that you need to know when working with SCPI commands are described here. For a more complete description, refer to the User Manual of the R&S FSQ.

Remote command examples

Note that some remote command examples mentioned in this general introduction may not be supported by this particular application.

9.2.1 Long and Short Form

The keywords have a long and a short form. You can use either the long or the short form, but no other abbreviations of the keywords.

The short form is emphasized in upper case letters. Note however, that this emphasis only serves the purpose to distinguish the short from the long form in the manual. For the instrument, the case does not matter.

Example:

`SENSe:FREQuency:CENTer` is the same as `SENS:FREQ:CENT`.

9.2.2 Numeric Suffixes

Some keywords have a numeric suffix if the command can be applied to multiple instances of an object. In that case, the suffix selects a particular instance (e.g. a measurement window).

Numeric suffixes are indicated by angular brackets (<n>) next to the keyword.

If you don't quote a suffix for keywords that support one, a 1 is assumed.

Example:

`DISPlay[:WINDow<1...4>]:ZOOM:STATe` enables the zoom in a particular measurement window, selected by the suffix at `WINDow`.

`DISPlay:WINDow4:ZOOM:STATe ON` refers to window 4.

9.2.3 Optional Keywords

Some keywords are optional and are only part of the syntax because of SCPI compliance. You can include them in the header or not.

Note that if an optional keyword has a numeric suffix and you need to use the suffix, you have to include the optional keyword. Otherwise, the suffix of the missing keyword is assumed to be the value 1.

Optional keywords are emphasized with square brackets.

Example:

Without a numeric suffix in the optional keyword:

`[SENSe:]FREQuency:CENTer` is the same as `FREQuency:CENTer`

With a numeric suffix in the optional keyword:

`DISPlay[:WINDow<1...4>]:ZOOM:STATe`

`DISPlay:ZOOM:STATe ON` enables the zoom in window 1 (no suffix).

`DISPlay:WINDow4:ZOOM:STATe ON` enables the zoom in window 4.

9.2.4 Alternative Keywords

A vertical stroke indicates alternatives for a specific keyword. You can use both keywords to the same effect.

Example:

`[SENSe:]BANDwidth|BWIDth[:RESolution]`

In the short form without optional keywords, `BAND 1MHZ` would have the same effect as `BWID 1MHZ`.

9.2.5 SCPI Parameters

Many commands feature one or more parameters.

If a command supports more than one parameter, these are separated by a comma.

Example:

```
LAYout:ADD:WINDow Spectrum,LEFT,MTABle
```

Parameters may have different forms of values.

- Numeric Values 89
- Boolean 89
- Character Data 90
- Character Strings 90
- Block Data 90

9.2.5.1 Numeric Values

Numeric values can be entered in any form, i.e. with sign, decimal point or exponent. In case of physical quantities, you can also add the unit. If the unit is missing, the command uses the basic unit.

Example:

with unit: `SENSe:FREQuency:CENTer 1GHZ`

without unit: `SENSe:FREQuency:CENTer 1E9` would also set a frequency of 1 GHz.

Values exceeding the resolution of the instrument are rounded up or down.

If the number you have entered is not supported (e.g. in case of discrete steps), the command returns an error.

Instead of a number, you can also set numeric values with a text parameter in special cases.

- MIN/MAX
  Defines the minimum or maximum numeric value that is supported.
- DEF
  Defines the default value.
- UP/DOWN
  Increases or decreases the numeric value by one step. The step size depends on the setting. In some cases you can customize the step size with a corresponding command.

Querying numeric values

When you query numeric values, the system returns a number. In case of physical quantities, it applies the basic unit (e.g. Hz in case of frequencies). The number of digits after the decimal point depends on the type of numeric value.

Example:

Setting: `SENSe:FREQuency:CENTer 1GHZ`

Query: `SENSe:FREQuency:CENTer?` would return `1E9`

In some cases, numeric values may be returned as text.

- INF/NINF
  Infinity or negative infinity. Represents the numeric values 9.9E37 or -9.9E37.
- NAN
  Not a number. Represents the numeric value 9.91E37. NAN is returned in case of errors.

9.2.5.2 Boolean

Boolean parameters represent two states. The "ON" state (logically true) is represented by "ON" or a numeric value 1. The "OFF" state (logically untrue) is represented by "OFF" or the numeric value 0.

Querying boolean parameters

When you query boolean parameters, the system returns either the value 1 ("ON") or the value 0 ("OFF").

Example:

Setting: `DISPlay:WINDow:ZOOM:STATe ON`

Query: `DISPlay:WINDow:ZOOM:STATe?` would return `1`

9.2.5.3 Character Data

Character data follows the syntactic rules of keywords. You can enter text using a short or a long form. For more information see chapter 9.2.1, "Long and Short Form", on page 87.

Querying text parameters

When you query text parameters, the system returns its short form.

Example:

Setting: `SENSe:BANDwidth:RESolution:TYPE NORMal`

Query: `SENSe:BANDwidth:RESolution:TYPE?` would return `NORM`

9.2.5.4 Character Strings

Strings are alphanumeric characters. They have to be in straight quotation marks. You can use a single quotation mark (') or a double quotation mark (").

Example:

```
INSTRument:DELete 'Spectrum'
```

9.2.5.5 Block Data

Block data is a format which is suitable for the transmission of large amounts of data.

The ASCII character # introduces the data block. The next number indicates how many of the following digits describe the length of the data block. In the example the 4 following digits indicate the length to be 5168 bytes. The data bytes follow. During the transmission of these data bytes all end or other control signs are ignored until all bytes are transmitted. #0 specifies a data block of indefinite length. The use of the indefinite format requires a NL^END message to terminate the data block. This format is useful when the length of the transmission is not known or if speed or other considerations prevent segmentation of the data into blocks of definite length.

9.3 Selecting and Configuring Measurements

9.3.1 Selecting Measurements

CALCulate<n>:FEED....91
DISPlay[:WINDow<n>]:TABLe....91

CALCulate<n>:FEED <DispType>

This command selects the measurement and result display.

Parameters:

<DispType> String containing the short form of the result display.

'EVM:EVCA' (EVM vs carrier result display)
'EVM:EVRP' (EVM vs RB)
'EVM:EVSY' (EVM vs symbol result display)
'EVM:FEVS' (frequency error vs symbol result display)
'EVM:EVSU' (EVM vs subframe result display)
'PVT:CBUF' (capture buffer result display)
'PVT:OOP' (on/off power result display)
'SPEC:SEM' (spectrum emission mask)
'SPEC:ACP' (ACLR)
'SPEC:PSPE' (power spectrum result display)
'SPEC:PVRP' (power vs RB PDSCH result display
'SPEC:PVRR' (power vs RB RS result display)
'SPEC:FLAT' (spectrum flatness result display)
'SPEC:GDEL' (group delay result display)
'SPEC:FDIF' (flatness difference result display)
'CONS:CONS' (constellation diagram)
'STAT:BSTR' (bitstream)
'STAT:ASUM' (allocation summary)
'STAT:CCDF' (CCDF)

Example: `CALC2:FEED 'PVT:CBUF'`
Select Capture Buffer to be displayed on screen B.

DISPlay[:WINDow<n>]:TABLe <State>

This command turns the result summary on and off.

Parameters:

<State>

ON
Turns the result summary on and removes all graphical results from the screen.

OFF
Turns the result summary off and restores the graphical results that were previously set.

Example: `DISP:TABL OFF`
Turns the result summary off.

9.3.2 Configuring Frequency Sweep Measurements

ACLR and SEM measurements feature some settings particular to those measurements.

[SENSe]:POWer:ACHannel:AACHannel....92
[SENSe]:POWer:NCORrection....92
[SENSe]:POWer:SEM:CATegory....93
[SENSe]:SWEep:EGATe:AUTO....93

[SENSe]:POWer:ACHannel:AACHannel <Channel>

This command selects the assumed adjacent channel carrier for ACLR measurements.

Parameters:

<Channel>

EUTRA
Selects an EUTRA signal of the same bandwidth like the TX channel as assumed adjacent channel carrier.

UTRA128
Selects an UTRA signal with a bandwidth of 1.28MHz as assumed adjacent channel carrier.

UTRA384
Selects an UTRA signal with a bandwidth of 3.84MHz as assumed adjacent channel carrier.

UTRA768
Selects an UTRA signal with a bandwidth of 7.68MHz as assumed adjacent channel carrier.

*RST: EUTRA

Example: `POW:ACH:AACH UTRA384`
Selects an UTRA signal with a bandwidth of 3.84MHz as assumed adjacent channel carrier.

[SENSe]:POWer:NCORrection <State>

This command turns noise correction for ACLR measurements on and off.

Parameters:

<State> ON | OFF

*RST: OFF

Example: `POW:NCOR ON`

Activates noise correction.

[SENSe]:POWer:SEM:CATegory <Category>

This command selects the SEM limit category as defined in 3GPP TS 36.104.

Parameters:

<Category> **A**

Category A

B

Category B

*RST: A

Example: `POW:SEM:CAT B`

Selects SEM category B.

[SENSe]:SWEep:EGATe:AUTO <State>

This command turns auto gating for SEM and ACLR measurements on and off.

This command is available for TDD measurements in combination with an external or IF power trigger.

Parameters:

<State> **ON**

Evaluates the on-period of the LTE signal only.

OFF

Evaluates the complete signal.

Example: `SWE:EGAT:AUTO ON`

Turns auto gating on.

9.4 Remote Commands to Perform Measurements

INITiate:CONTinuous....93
INITiate[:IMMediate]....94
INITiate:REFResh....94
[SENSe][:LTE]:OOPower:ATIMing....94
[SENSe]:SYNC[:STATe]?....95

INITiate:CONTinuous <State>

This command controls the sweep mode.

Parameters:

<State> ON | OFF

ON
Continuous sweep

OFF
Single sweep

*RST: OFF

Example: `INIT:CONT OFF`
Switches the sequence to single sweep.
`INIT:CONT ON`
Switches the sequence to continuous sweep.

INITiate[:IMMediate]

This command initiates a new measurement sequence.

With a frame count > 0, this means a restart of the corresponding number of measurements.

In single sweep mode, you can synchronize to the end of the measurement with `*OPC`. In continuous sweep mode, synchronization to the end of the sweep is not possible.

Example: `INIT`
Initiates a new measurement.

Usage: Event

INITiate:REFResh

This command updates the current I/Q measurement results to reflect the current measurement settings.

No new I/Q data is captured. Thus, measurement settings apply to the I/Q data currently in the capture buffer.

The command applies exclusively to I/Q measurements. It requires I/Q data.

Example: `INIT:REFR`
The application updates the IQ results

Usage: Event

[SENSe][:LTE]:OOPower:ATIMing

This command adjusts the timing for On/Off Power measurements.

Example: `OOP:ATIM`
Adjusts the On/Off Power timing.

Usage: Event

[SENSe]:SYNC[:STATe]?

This command queries the current synchronization state.

Return values:

<State> The string contains the following information.
- <OFDMSymbolTiming> is the coarse symbol timing
- <P-SYNCSynchronization> is the P-SYNC synchronization state
- <S-SYNCSynchronization> is the S-SYNC synchronization state

A zero represents a failure and a one represents a successful synchronization.

Example: `SYNC:STAT?`
Would return, e.g. '1,1,0' if coarse timing and P-SYNC were successful but S-SYNC failed.

Usage: Query only

9.5 Remote Commands to Read Numeric Results

FETCh:CYCPrefix?....96
FETCh:PLC:CIDGroup?....96
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FETCh:SUMMary:CRESt[:AVERage]?....97
FETCh:SUMMary:EVM[:ALL]:MAXimum?....97
FETCh:SUMMary:EVM[:ALL]:MINimum?....97
FETCh:SUMMary:EVM[:ALL][:AVERage]?....97
FETCh:SUMMary:EVM:DSQP:MAXimum?....97
FETCh:SUMMary:EVM:DSQP:MINimum?....97
FETCh:SUMMary:EVM:DSQP[:AVERage]?....97
FETCh:SUMMary:EVM:DSST:MAXimum?....98
FETCh:SUMMary:EVM:DSST:MINimum?....98
FETCh:SUMMary:EVM:DSST[:AVERage]?....98
FETCh:SUMMary:EVM:DSSF:MAXimum?....98
FETCh:SUMMary:EVM:DSSF:MINimum?....98
FETCh:SUMMary:EVM:DSSF[:AVERage]?....98
FETCh:SUMMary:EVM:PCHannel:MAXimum?....98
FETCh:SUMMary:EVM:PCHannel:MINimum?....98
FETCh:SUMMary:EVM:PCHannel[:AVERage]?....98
FETCh:SUMMary:EVM:PSIGnal:MAXimum?....99
FETCh:SUMMary:EVM:PSIGnal:MINimum?....99
FETCh:SUMMary:EVM:PSIGnal[:AVERage]?....99
FETCh:SUMMary:FERRor:MAXimum?....99
FETCh:SUMMary:FERRor:MINimum?....99
FETCh:SUMMary:FERRor[:AVERage]?....99
FETCh:SUMMary:GIMBalance:MAXimum?....99
FETCh:SUMMary:GIMBalance:MINimum?....99
FETCh:SUMMary:GIMBalance[:AVERage]?....99
FETCh:SUMMary:IQOFfset:MAXimum?....100

FETCh:SUMMary:IQOFfset:MINimum?....100
FETCh:SUMMary:IQOFfset[:AVERage]?....100
FETCh:SUMMary:OSTP:MAXimum?....100
FETCh:SUMMary:OSTP:MINimum?....100
FETCh:SUMMary:OSTP[:AVERage]?....100
FETCh:SUMMary:POWer:MAXimum?....100
FETCh:SUMMary:POWer:MINimum?....100
FETCh:SUMMary:POWer[:AVERage]?....100
FETCh:SUMMary:QUADerror:MAXimum?....101
FETCh:SUMMary:QUADerror:MINimum?....101
FETCh:SUMMary:QUADerror[:AVERage]?....101
FETCh:SUMMary:RSTP:MAXimum?....101
FETCh:SUMMary:RSTP:MINimum?....101
FETCh:SUMMary:RSTP[:AVERage]?....101
FETCh:SUMMary:SERRor:MAXimum?....101
FETCh:SUMMary:SERRor:MINimum?....101
FETCh:SUMMary:SERRor[:AVERage]?....101
FETCh:SUMMary:TAE<antenna>?....101
FETCh:SUMMary:TFRame?....102

FETCh:CYCPrefix?

This command queries the cyclic prefix type that has been detected.

Return values:

<PrefixType> The command returns -1 if no valid result has been detected yet.

NORM
Normal cyclic prefix length detected

EXT
Extended cyclic prefix length detected

Example: `FETC:CYCP?`
Returns the current cyclic prefix length type.

Usage: Query only

FETCh:PLC:CIDGroup?

This command queries the cell identity group that has been detected.

Return values:

<CidGroup> The command returns -1 if no valid result has been detected yet.

Range: 0 to 167

Example: `FETC:PLC:CIDG?`
Returns the current cell identity group.

Usage: Query only

FETCh:PLC:PLID?

This command queries the cell identity that has been detected.

Return values:

<Identity> The command returns -1 if no valid result has been detected yet.
Range: 0 to 2

Example: `FETC:PLC:PLID?`
Returns the current cell identity.

Usage: Query only

FETCh:SUMMary:CRESt[:AVERage]?

This command queries the average crest factor as shown in the result summary.

Return values:

<CrestFactor> <numeric value>
Crest Factor in dB.

Example: `FETC:SUMM:CRES?`
Returns the current crest factor in dB.

Usage: Query only

FETCh:SUMMary:EVM[:ALL]:MAXimum?
FETCh:SUMMary:EVM[:ALL]:MINimum?
FETCh:SUMMary:EVM[:ALL][:AVERage]?

This command queries the EVM of all resource elements.

Return values:

<EVM> <numeric value>
Minimum, maximum or average EVM, depending on the last command syntax element.
The unit is % or dB, depending on your selection.

Example: `FETC:SUMM:EVM?`
Returns the mean value.

Usage: Query only

FETCh:SUMMary:EVM:DSQP:MAXimum?
FETCh:SUMMary:EVM:DSQP:MINimum?
FETCh:SUMMary:EVM:DSQP[:AVERage]?

This command queries the EVM of all resource elements of the PDSCH with a QPSK modulation.

Return values:

<EVM> <numeric value>
EVM in % or dB, depending on the unit you have set.

Example: `FETC:SUMM:EVM:DSQP?`
Returns the PDSCH QSPK EVM.

Usage: Query only

FETCh:SUMMary:EVM:DSST:MAXimum?
FETCh:SUMMary:EVM:DSST:MINimum?
FETCh:SUMMary:EVM:DSST[:AVERage]?

This command queries the EVM of all resource elements of the PDSCH with a 16QAM modulation.

Return values:
<EVM> <numeric value>
EVM in % or dB, depending on the unit you have set.

Example: `FETC:SUMM:EVM:DSST?`
Returns the PDSCH 16QAM EVM.

Usage: Query only

FETCh:SUMMary:EVM:DSSF:MAXimum?
FETCh:SUMMary:EVM:DSSF:MINimum?
FETCh:SUMMary:EVM:DSSF[:AVERage]?

This command queries the EVM of all resource elements of the PDSCH with a 64QAM modulation.

Return values:
<EVM> <numeric value>
EVM in % or dB, depending on the unit you have set.

Example: `FETC:SUMM:EVM:DSSF?`
Returns the PDSCH 64QAM EVM.

Usage: Query only

FETCh:SUMMary:EVM:PCHannel:MAXimum?
FETCh:SUMMary:EVM:PCHannel:MINimum?
FETCh:SUMMary:EVM:PCHannel[:AVERage]?

This command queries the EVM of all physical channel resource elements.

Return values:
<EVM> <numeric value>
Minimum, maximum or average EVM, depending on the last command syntax element.
The unit is % or dB, depending on your selection.

Example: `FETC:SUMM:EVM:PCH?`
Returns the mean value.

Usage: Query only

FETCh:SUMMary:EVM:PSIGnal:MAXimum?
FETCh:SUMMary:EVM:PSIGnal:MINimum?
FETCh:SUMMary:EVM:PSIGnal[:AVERage]?

This command queries the EVM of all physical signal resource elements.

Return values:

<EVM> <numeric value>

Minimum, maximum or average EVM, depending on the last command syntax element.
The unit is % or dB, depending on your selection.

Example: `FETC:SUMM:EVM:PSIG?`
Returns the mean value.

Usage: Query only

FETCh:SUMMary:FERRor:MAXimum?
FETCh:SUMMary:FERRor:MINimum?
FETCh:SUMMary:FERRor[:AVERage]?

This command queries the frequency error.

Return values:

<FreqError> <numeric value>

Minimum, maximum or average frequency error, depending on the last command syntax element.

Default unit: Hz

Example: `FETC:SUMM:FERR?`
Returns the average frequency error in Hz.

Usage: Query only

FETCh:SUMMary:GIMBalance:MAXimum?
FETCh:SUMMary:GIMBalance:MINimum?
FETCh:SUMMary:GIMBalance[:AVERage]?

This command queries the I/Q gain imbalance.

Return values:

<GainImbalance> <numeric value>

Minimum, maximum or average I/Q imbalance, depending on the last command syntax element.

Default unit: dB

Example: `FETC:SUMM:GIMB?`
Returns the current gain imbalance in dB.

Usage: Query only

FETCh:SUMMary:IQOFfset:MAXimum?
FETCh:SUMMary:IQOFfset:MINimum?
FETCh:SUMMary:IQOFfset[:AVERage]?

This command queries the I/Q offset.

Return values:

<IQOffset> <numeric value>

Minimum, maximum or average I/Q offset, depending on the last command syntax element.

Default unit: dB

Example: `FETC:SUMM:IQOF?`
Returns the current IQ-offset in dB

Usage: Query only

FETCh:SUMMary:OSTP:MAXimum?
FETCh:SUMMary:OSTP:MINimum?
FETCh:SUMMary:OSTP[:AVERage]?

This command queries the OSTP.

Return values:

<OSTP> <numeric value>

Minimum, maximum or average OSTP, depending on the last command syntax element.

Default unit: dBm

Example: `FETC:SUMM:OSTP?`
Returns the current average OSTP value.

Usage: Query only

FETCh:SUMMary:POWer:MAXimum?
FETCh:SUMMary:POWer:MINimum?
FETCh:SUMMary:POWer[:AVERage]?

This command queries the total power.

Return values:

<Power> <numeric value>

Minimum, maximum or average power, depending on the last command syntax element.

Default unit: dBm

Example: `FETC:SUMM:POW?`
Returns the total power in dBm

Usage: Query only

FETCh:SUMMary:QUADerror:MAXimum?
FETCh:SUMMary:QUADerror:MINimum?
FETCh:SUMMary:QUADerror[:AVERage]?

This command queries the quadrature error.

Return values:

<QuadError> <numeric value>

Minimum, maximum or average quadrature error, depending on the last command syntax element.

Default unit: deg

Example: `FETC:SUMM:QUAD?`

Returns the current mean quadrature error in degrees.

Usage: Query only

FETCh:SUMMary:RSTP:MAXimum?
FETCh:SUMMary:RSTP:MINimum?
FETCh:SUMMary:RSTP[:AVERage]?

This command queries the RSTP as shown in the result summary.

Return values:

<RSTP> RSTP in dBm.

Example: `FETC:SUMM:RSTP?`

Queries the RSTP.

Usage: Query only

FETCh:SUMMary:SERRor:MAXimum?
FETCh:SUMMary:SERRor:MINimum?
FETCh:SUMMary:SERRor[:AVERage]?

This command queries the sampling error.

Return values:

<SamplingError> <numeric value>

Minimum, maximum or average sampling error, depending on the last command syntax element.

Default unit: ppm

Example: `FETC:SUMM:SERR?`

Returns the current mean sampling error in ppm.

Usage: Query only

FETCh:SUMMary:TAE<antenna>?

This command queries the time alignment error.

Suffix:
<antenna> 2..4
Number of the antenna you want to compare to antenna 1.

Return values:
<TimeAlignError>
Time alignment error of antenna 1 and another antenna.

Usage: Query only

FETCh:SUMMary:TFRame?

This command queries the trigger to frame result for downlink signals and the trigger to subframe result for uplink signals.

Return values:
<TrigToFrame> <numeric value>
Default unit: s

Example: `FETC:SUMM:TFR?`
Returns the trigger to frame value.

Usage: Query only

9.6 Remote Commands to Read Trace Data

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9.6.1 Using the TRACe[:DATA] Command

This chapter contains information on the TRACe:DATA command and a detailed description of the characteristics of that command.

The TRACe:DATA command queries the trace data or results of the currently active measurement or result display. The type, number and structure of the return values are specific for each result display. In case of results that have any kind of unit, the command returns the results in the unit you have currently set for that result display.

Note also that return values for results that are available for both downlink and uplink may be different.

For several result displays, the command also supports various SCPI parameters in combination with the query. If available, each SCPI parameter returns a different aspect of the results. If SCPI parameters are supported, you have to quote one in the query.

Example:

```
TRAC:DATA? TRACE1
```

The format of the return values is either in ASCII or binary characters and depends on the format you have set with `FORMat[:DATA]`.

Following this detailed description, you will find a short summary of the most important functions of the command (`TRACe[:DATA]?`).

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9.6.1.1 Adjacent Channel Leakage Ratio

For the ACLR result display, the number and type of returns values depend on the parameter.

- TRACE1
  Returns one value for each trace point.
- LIST
  Returns the contents of the ACLR table.

9.6.1.2 Allocation Summary

For the Allocation Summary, the command returns seven values for each line of the table.

`<subframe>, <allocation ID>, <number of RB>, <relative power>, <modulation>, <absolute power>, <EVM>, ...`

The unit for `<absolute power>` is always dBm. The unit for `<relative power>` is always dB. The unit for `<EVM>` depends on `UNIT:EVM`. All other values have no unit.

The `<allocation ID>` and `<modulation>` are encoded. For the code assignment see chapter 9.6.1.19, "Return Value Codes", on page 110.

Note that the data format of the return values is always ASCII.

Example:

`TRAC:DATA? TRACE1` would return:

```
0, -5, 0, 0.0000000000000, 2, -45.5463829153428, 7.33728660354122E-05,
0, -3, 0, 0.0073997452251, 6, -42.5581007463452, 2.54197349219455E-05,
0, -4, 0, 0.0052647197362, 1, -42.5464220485716, 2.51485275782241E-05,
...
```

9.6.1.3 Bit Stream

For the Bit Stream result display, the command returns five values and the bitstream for each line of the table.

`<subframe>, <allocation ID>, <codeword>, <modulation>, <# of symbols/bits>, <hexadecimal/binary numbers>,...`

All values have no unit. The format of the bitstream depends on Bit Stream Format.

The `<allocation ID>`, `<codeword>` and `<modulation>` are encoded. For the code assignment see chapter 9.6.1.19, "Return Value Codes", on page 110.

For symbols or bits that are not transmitted, the command returns

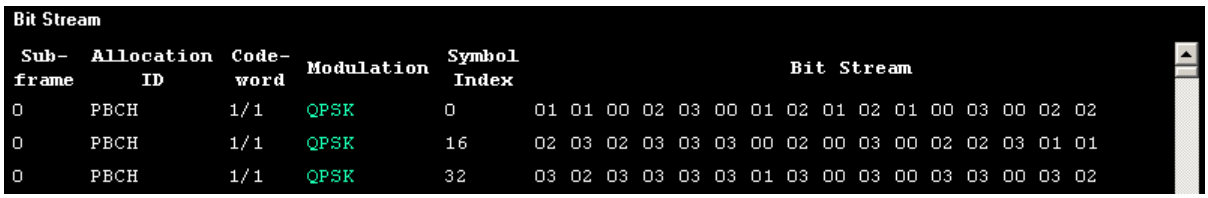
- "FF" if the bit stream format is "Symbols"
- "9" if the bit stream format is "Bits".

For symbols or bits that could not be decoded because the number of layer exceeds the number of receive antennas, the command returns

- "FE" if the bit stream format is "Symbols"
- "8" if the bit stream format is "Bits".

Note that the data format of the return values is always ASCII.

Example:



Bit Stream

Sub-frame	Allocation ID	Code-word	Modulation	Symbol Index	Bit Stream
0	PBCH	1/1	QPSK	0	01 01 00 02 03 00 01 02 01 02 01 00 03 00 02 02
0	PBCH	1/1	QPSK	16	02 03 02 03 03 03 00 02 00 03 00 02 02 03 01 01
0	PBCH	1/1	QPSK	32	03 02 03 03 03 03 01 03 00 03 00 03 03 00 03 02

`TRAC:DATA? TRACE1` would return:

```
0, -12, 0, 2, 0, 01, 01, 00, 02, 03, 00, 01, 02, 01, 02, 01, ...
<continues like this until the next data block starts or the end of data is reached>
0, -12, 0, 2, 32, 03, 02, 03, 03, 03, 03, 01, 03, 00, 03, ...
```

9.6.1.4 Capture Buffer

For the Capture Buffer result display, the command returns one value for each I/Q sample in the capture buffer.

```
<absolute power>, ...
```

The unit is always dBm.

The following parameters are supported.

- TRACE1

9.6.1.5 CCDF

For the CCDF result display, the type of return values depends on the parameter.

- TRACE1
  Returns the probability values (y-axis).
  `<# of values>, <probability>, ...`
  The unit is always %.
  The first value that is returned is the number of the following values.
- TRACE2
  Returns the corresponding power levels (x-axis).
  `<# of values>, <relative power>, ...`
  The unit is always dB.
  The first value that is returned is the number of the following values.

9.6.1.6 Channel Flatness

For the Channel Flatness result display, the command returns one value for each trace point.

```
<relative power>, ...
```

The unit is always dB.

The following parameters are supported.

- TRACE1
  Returns the average power over all subframes.
- TRACE2
  Returns the minimum power found over all subframes. If you are analyzing a particular subframe, it returns nothing.
- TRACE3
  Returns the maximum power found over all subframes. If you are analyzing a particular subframe, it returns nothing.

9.6.1.7 Channel Flatness Difference

For the Channel Flatness Difference result display, the command returns one value for each trace point.

```
<relative power>, ...
```

The unit is always dB. The number of values depends on the selected LTE bandwidth.

The following parameters are supported.

- TRACE1
  Returns the average power over all subframes.
- TRACE2
  Returns the minimum power found over all subframes. If you are analyzing a particular subframe, it returns nothing.
- TRACE3
  Returns the maximum power found over all subframes. If you are analyzing a particular subframe, it returns nothing.

9.6.1.8 Channel Group Delay

For the Channel Group Delay result display, the command returns one value for each trace point.

```
<group delay>, ...
```

The unit is always ns. The number of values depends on the selected LTE bandwidth.

The following parameters are supported.

- TRACE1
  Returns the group delay.

9.6.1.9 Constellation Diagram

For the Constellation Diagram, the command returns two values for each constellation point.

<I[SF0][Symb0][Carrier1]>, <Q[SF0][Symb0][Carrier1]>, ..., <I[SF0][Symb0][Carrier(n)]>, <Q[SF0][Symb0][Carrier(n)]>,

<I[SF0][Symb1][Carrier1]>, <Q[SF0][Symb1][Carrier1]>, ..., <I[SF0][Symb1][Carrier(n)]>, <Q[SF0][Symb1][Carrier(n)]>,

<I[SF0][Symb(n)][Carrier1]>, <Q[SF0][Symb(n)][Carrier1]>, ..., <I[SF0][Symb(n)][Carrier(n)]>, <Q[SF0][Symb(n)][Carrier(n)]>,

<I[SF1][Symb0][Carrier1]>, <Q[SF1][Symb0][Carrier1]>, ..., <I[SF1][Symb0][Carrier(n)]>, <Q[SF1][Symb0][Carrier(n)]>,

<I[SF1][Symb1][Carrier1]>, <Q[SF1][Symb1][Carrier1]>, ..., <I[SF1][Symb1][Carrier(n)]>, <Q[SF1][Symb1][Carrier(n)]>,

<I[SF(n)][Symb(n)][Carrier1]>, <Q[SF(n)][Symb(n)][Carrier1]>, ..., <I[SF(n)][Symb(n)][Carrier(n)]>, <Q[SF(n)][Symb(n)][Carrier(n)]>

With SF = subframe and Symb = symbol of that subframe.

The I and Q values have no unit.

The number of return values depends on the constellation selection. By default, it returns all resource elements including the DC carrier.

The following parameters are supported.

- TRACE1
  Returns all constellation points included in the selection.

9.6.1.10 EVM vs Carrier

For the EVM vs Carrier result display, the command returns one value for each subcarrier that has been analyzed.

```
<EVM>, ...
```

The unit depends on `UNIT:EVM`.

The following parameters are supported.

- TRACE1
  Returns the average EVM over all subframes
- TRACE2
  Returns the minimum EVM found over all subframes. If you are analyzing a particular subframe, it returns nothing.
- TRACE3
  Returns the maximum EVM found over all subframes. If you are analyzing a particular subframe, it returns nothing.

9.6.1.11 EVM vs Symbol

For the EVM vs Symbol result display, the command returns one value for each OFDM symbol that has been analyzed.

```
<EVM>, ...
```

For measurements on a single subframe, the command returns the symbols of that subframe only.

The unit depends on UNIT:EVM.

The following parameters are supported.

- TRACE1

9.6.1.12 EVM vs Subframe

For the EVM vs Subframe result display, the command returns one value for each subframe that has been analyzed.

```
<EVM>, ...
```

The unit depends on UNIT:EVM.

The following parameters are supported.

- TRACE1

9.6.1.13 Frequency Error vs Symbol

For the Frequency Error vs Symbol result display, the command returns one value for each OFDM symbol that has been analyzed.

```
<frequency error>,...
```

The unit is always Hz.

The following parameters are supported.

- TRACE1

9.6.1.14 On/Off Power

For the On/Off Power measurement, the number and type of return values depend on the parameter.

- TRACE1
  Returns the power for the Off power regions.
  `<absolute power>,...`
  The unit is always dBm.
- TRACE2
  Returns the power for the transient regions.
  `<absolute power>,...`
  The unit is always dBm.
- LIST
  Returns the contents of the On/Off Power table. For each line, it returns seven values.
  `<off period start limit>, <off period stop limit>, <time at delta to limit>, <absolute off power>, <distance to limit>, <falling transient period>, <rising transient period>,...`

The unit for the <absolute off power> is dBm. The unit for the <distance to limit> is dB. The unit for the <transient periods> is µs. All other values have the unit s.

9.6.1.15 Power Spectrum

For the Power Spectrum result display, the command returns one value for each trace point.

<power>,...

The unit is always dBm/Hz.

The following parameters are supported.

- TRACE1

9.6.1.16 Power vs RB RS

For the Power vs RB RS, the command returns one value for each resource block of the reference signal that has been analyzed.

<absolute power>,...

The unit is always dBm.

The following parameters are supported.

- TRACE1
  Returns the average power over all subframes
- TRACE2
  Returns the minimum power found over all subframes. If you are analyzing a particular subframe, it returns nothing.
- TRACE3
  Returns the maximum power found over all subframes. If you are analyzing a particular subframe, it returns nothing.

9.6.1.17 Power vs RB PDSCH

For the Power vs RB PDSCH, the command returns one value for each resource block of the PDSCH that has been analyzed.

<absolute power>,...

The unit is always dBm.

The following parameters are supported.

- TRACE1
  Returns the average power over all subframes
- TRACE2
  Returns the minimum power found over all subframes. If you are analyzing a particular subframe, it returns nothing.

- TRACE3
  Returns the maximum power found over all subframes. If you are analyzing a particular subframe, it returns nothing.

9.6.1.18 Spectrum Emission Mask

For the SEM measurement, the number and type of returns values depend on the parameter.

- TRACE1
  Returns one value for each trace point.
  `<absolute power>, ...`
  The unit is always dBm.
- LIST
  Returns the contents of the SEM table. For every frequency in the spectrum emission mask, it returns nine values.
  `<index>, <start frequency in Hz>, <stop frequency in Hz>, <RBW in Hz>, <limit fail frequency in Hz>, <absolute power in dBm>, <relative power in dBc>, <limit distance in dB>, <limit check result>, ...`
  The `<limit check result>` is either a 0 (for PASS) or a 1 (for FAIL).

9.6.1.19 Return Value Codes

This chapter contains a list for encoded return values.

<ACK/NACK>

The range is {-1...1}.

- **1** = ACK
- **0** = NACK
- **-1** = DTX

<allocation ID>

Represents the allocation ID. The range is {-13...65535}.

- **0 - 65535** = PDSCH
- **-1** = Invalid
- **-2** = All
- **-3** = P-SYNC
- **-4** = S-SYNC
- **-5** = PILOTS_ANT1
- **-6** = PILOTS_ANT2
- **-7** = PILOTS_ANT3
- **-8** = PILOTS_ANT4
- **-9** = PCFICH

- **-10** = PHICH
- **-11** = PDCCH
- **-12** = PBCH
- **-13** = PMCH

<codeword>

Represents the codeword of an allocation. The range is {0...2}.

- **0** = 1/1
- **1** = 1/2
- **2** = 2/2

<DCI format>

Represents the DCi format. The value is a number in the range {0...103}.

- **0** = DCI format 0
- **10** = DCI format 1
- **11** = DCI format 1A
- **12** = DCI format 1B
- **13** = DCI format 1C
- **14** = DCI format 1D
- **20** = DCI format 2
- **21** = DCI format 2A
- **22** = DCI format 2B
- **30** = DCI format 3
- **31** = DCI format A
- **103** = DCI format 0/3/3A

<modulation>

Represents the modulation scheme. The range is {0...8}.

- **0** = unrecognized
- **1** = RBPSK
- **2** = QPSK
- **3** = 16QAM
- **4** = 64QAM
- **5** = 8PSK
- **6** = PSK
- **7** = mixed modulation
- **8** = BPSK

<number of symbols or bits>

In hexadecimal mode, this represents the number of symbols to be transmitted. In binary mode, it represents the number of bits to be transmitted.

<PHICH duration>

Represents the PHICH duration. The range is {1...2}.

- **1** = normal
- **2** = extended

<PHICH resource>

Represents the parameter N_g. The range is {1...4}.

- **1** = N_g 1/6
- **2** = N_g 1/2
- **3** = N_g 1
- **4** = N_g 2

TRACe[:DATA]? <Result>

This command returns the trace data for the current measurement or result display.

For more information see chapter 9.6.1, "Using the TRACe[:DATA] Command", on page 102.

Query parameters:

<TraceNumber> **TRACE1 | TRACE2 | TRACE3**

LIST

PBCH

PCFICH

PHICH

PDCCH

Usage: Query only

9.6.2 Remote Commands to Read Measurement Results

CALCulate<n>:LIMit<k>:ACPower:ACHannel:RESult?....112
CALCulate<n>:LIMit<k>:ACPower:ALTernate:RESult?....113
CALCulate<n>:LIMit<k>:OOPower:OFFPower?....114
CALCulate<n>:LIMit<k>:OOPower:TRANsient?....114
CALCulate<n>:MARKer<m>:FUNCtion:POWer:RESult[:CURRent]?....114

CALCulate<n>:LIMit<k>:ACPower:ACHannel:RESult? <Result>

This command queries the limit check results for the adjacent channels during ACLR measurements.

Query parameters:

<Result>

ALL
Queries the overall limit check results.

REL
Queries the channel power limit check results.

ABS
Queries the distance to the limit line.

Return values:

<LimitCheck>

Returns two values, one for the upper and one for the lower adjacent channel.

1
Limit check has passed.

0
Limit check has failed.

Example:

```
CALC:LIM:ACP:ACH:RES? ALL
```

Queries the results of the adjacent channel limit check.

Usage: Query only

CALCulate<n>:LIMit<k>:ACPower:ALTernate:RESult? <Result>

This command queries the limit check results for the alternate channels during ACLR measurements.

Query parameters:

<Result>

ALL
Queries the overall limit check results.

REL
Queries the channel power limit check results.

ABS
Queries the distance to the limit line.

Return values:

<LimitCheck>

Returns two values, one for the upper and one for the lower alternate channel.

1
Limit check has passed.

0
Limit check has failed.

Example:

```
CALC:LIM:ACP:ALT:RES? ALL
```

Queries the results of the alternate channel limit check.

Usage: Query only

CALCulate<n>:LIMit<k>:OOPower:OFFPower?

This command queries the results of the limit check in the "Off" periods of On/Off Power measurements.

Return values:

<OOPResults> Returns one value for every "Off" period.

1
Limit check has passed.

0
Limit check has failed.

Example: `CALC:LIM:OOP:OFFP?`
Queries the results for the limit check during the signal Off periods.

Usage: Query only

CALCulate<n>:LIMit<k>:OOPower:TRANsient?

This command queries the results of the limit check during the transient periods of the On/Off power measurement.

Query parameters:

<Result> **ALL**
Queries the overall limit check results.

FALLing
Queries the limit check results of falling transients.

RISing
Queries the limit check results of rising transients.

Return values:

<OOPResults> Returns one value for every "Off" period.

1
Limit check has passed.

0
Limit check has failed.

Example: `CALC:LIM:OOP:TRAN? RIS`
Queries the limit check of rising transients.

Usage: Query only

CALCulate<n>:MARKer<m>:FUNCtion:POWer:RESult[:CURRent]?

This command queries the current results of the ACLR measurement or the total signal power level of the SEM measurement.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweeps.

Suffix:
<m> 1

Query parameters:
CPOW This parameter queries the signal power of the SEM measurement.

Return values:
<Result> **SEMResults**
Power level in dBm.

ACLRResults
Relative power levels of the ACLR channels. The number of return values depends on the number of transmission and adjacent channels. The order of return values is:
• <TXChannelPower> is the power of the transmission channel in dBm
• <LowerAdjChannelPower> is the relative power of the lower adjacent channel in dB
• <UpperAdjChannelPower> is the relative power of the upper adjacent channel in dB
• <1stLowerAltChannelPower> is the relative power of the first lower alternate channel in dB
• <1stUpperAltChannelPower> is the relative power of the first lower alternate channel in dB
(...)
• <nthLowerAltChannelPower> is the relative power of a subsequent lower alternate channel in dB
• <nthUpperAltChannelPower> is the relative power of a subsequent lower alternate channel in dB

Example: `CALC1:MARK:FUNC:POW:RES?`
Returns the current ACLR measurement results.

Usage: Query only

9.7 Remote Commands to Configure the Application

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9.7.1 Remote Commands for General Settings

This chapter contains remote control commands necessary to control the general measurement settings.

For more information see chapter 6.2, "General Settings", on page 50.

9.7.1.1 Defining Signal Characteristics

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CONFigure[:LTE]:DL:BW <Bandwidth>

This command selects the downlink bandwidth.

Parameters:

<Bandwidth> BW1_40 | BW3_00 | BW5_00 | BW10_00 | BW15_00 | BW20_00

*RST: BW10_00

Example: `CONF:DL:BW BW1_40`
Sets a signal bandwidth of 1.4 MHz in downlink.

CONFigure[:LTE]:DL:CYCPrefix <PrefixLength>

This command selects the cyclic prefix for downlink signals.

Parameters:

<PrefixLength> **NORM**
Normal cyclic prefix length

EXT
Extended cyclic prefix length

AUTO
Automatic cyclic prefix length detection

*RST: AUTO

Example: `CONF:DL:CYCP EXT`
Sets cyclic prefix type to extended.

CONFigure[:LTE]:DL:NORB <ResourceBlocks>

This command selects the number of resource blocks for downlink signals.

Parameters:

<ResourceBlocks> <numeric value>

*RST: 50

Example: `CONF:DL:NORB 25`
Sets the number of resource blocks to 25.

CONFigure[:LTE]:DUPLexing <Duplexing>

This command selects the duplexing mode.

Parameters:

<Duplexing>
TDD
Time division duplex
FDD
Frequency division duplex
*RST: FDD

Example:
```
CONF:DUPL TDD
```
Activates time division duplex.

CONFigure[:LTE]:LDIRection <Direction>

This command selects the link direction

Parameters:

<Direction>
DL
Downlink
UL
Uplink

Example:
```
CONF:LDIR DL
```
EUTRA/LTE option is configured to analyze downlink signals.

[SENSe]:FREQuency:CENTer <Frequency>

This command sets the center frequency for RF measurements.

Parameters:

<Frequency>
<numeric value>
Range: fmin to fmax
*RST: 1 GHz
Default unit: Hz

Example:
```
FREQ:CENT 2GHZ
```
Set the center frequency to 2 GHz.

9.7.1.2 Configuring the Input Level

CONFigure:POWer:EXPected:IQ<analyzer>....118
CONFigure:POWer:EXPected:RF<analyzer>....118
DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RLEVel:OFFSet....118
INPut<n>:ATTenuation<analyzer>....118
INPut<n>:EATT....119
INPut<n>:EATT:STATe....119

INPut<n>:EATT:AUTO....119
[SENSe]:POWer:AUTO<analyzer>[:STATe]....119
[SENSe]:POWer:AUTO<analyzer>:TIME....120

CONFigure:POWer:EXPected:IQ<analyzer> <RefLevel>

This command defines the reference level when the input source is baseband.

Parameters:

<RefLevel> <numeric value>

Range: 31.6 mV to 5.62 V
*RST: 1 V
Default unit: V

Example: `CONF:POW:EXP:IQ2 3.61`
Sets the baseband-reference level used by analyzer 2 to 3.61 V.

CONFigure:POWer:EXPected:RF<analyzer> <RefLevel>

This command defines the reference level when the input source is RF.

Parameters:

<RefLevel> *RST: -30 dBm
Default unit: DBM

Example: `CONF:POW:EXP:RF3 -20`
Sets the radio frequency reference level used by analyzer 3 to -20 dBm.

DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RLEVel:OFFSet <Attenuation>

This command selects the external attenuation or gain applied to the RF signal.

Parameters:

<Attenuation> <numeric value>

*RST: 0
Default unit: dB

Example: `DISP:TRAC:Y:RLEV:OFFS 10`
Sets an external attenuation of 10 dB.

INPut<n>:ATTenuation<analyzer> <Attenuation>

This command sets the RF attenuation level.

Parameters:

<Attenuation> <numeric value>

*RST: 5 dB
Default unit: dB

Example: `INP:ATT 10`
Defines an RF attenuation of 10 dB.

INPut<n>:EATT <Attenuation>

This command defines the electronic attenuation level.

If the current reference level is not compatible with an attenuation that has been set manually, the command also adjusts the reference level.

This command is available with option R&S FSQ-B25, but not if R&S FSQ-B17 is active.

Parameters:

<Attenuation> Attenuation level in dB.

Default unit: dB

Example: `INP:EATT 10`

Defines an attenuation level of 10 dB.

INPut<n>:EATT:STATe <State>

This command turns the electronic attenuator on and off.

This command is available with option R&S FSQ-B25, but not if R&S FSQ-B17 is active.

Parameters:

<State> ON | OFF

*RST: OFF

Example: `INP:EATT:STAT ON`

Turns the electronic attenuator on.

INPut<n>:EATT:AUTO <State>

This command turns automatic selection of the electronic attenuation on and off.

If on, electronic attenuation reduces the mechanical attenuation whenever possible.

This command is available with option R&S FSQ-B25, but not if R&S FSQ-B17 is active.

Parameters:

<State> ON | OFF

*RST: OFF

Example: `INP:EATT:AUTO ON`

Turns automatic selection of electronic attenuation level on.

[SENSe]:POWer:AUTO<analyzer>[:STATe] <State>

This command initiates a measurement that determines the ideal reference level.

Parameters:

<State>

OFF
Performs no automatic reference level detection.

ON
Performs an automatic reference level detection before each measurement.

ONCE
Performs an automatic reference level once.

*RST: ON

Example: `POW:AUTO2 ON`
Activate auto level for analyzer number 2.

[SENSe]:POWer:AUTO<analyzer>:TIME <Time>

This command defines the track time for the auto level process.

Parameters:

<Time> <numeric value>

*RST: 100 ms
Default unit: s

Example: `POW:AUTO:TIME 200ms`
An auto level track time of 200 ms gets set.

9.7.1.3 Configuring the Data Capture

[SENSe][:LTE]:FRAMe:COUNt....120
[SENSe][:LTE]:FRAMe:COUNt:AUTO....120
[SENSe][:LTE]:FRAMe:COUNt:STATe....121
[SENSe]:SWEep:TIME....121

[SENSe][:LTE]:FRAMe:COUNt <Subframes>

This command sets the number of frames you want to analyze.

Parameters:

<Subframes> <numeric value>

*RST: 1

Example: `FRAM:COUN:STAT ON`
Activates manual input of frames to be analyzed.
`FRAM:COUN 20`
Analyzes 20 frames.

[SENSe][:LTE]:FRAMe:COUNt:AUTO <State>

This command turns automatic selection of the number of frames to analyze on and off.

Parameters:

<State>

ON
Selects the number of frames to analyze according to the LTE standard.

OFF
Turns manual selection of the frame number on.

Example:
```
FRAM:COUN:AUTO ON
```
Turns automatic selection of the analyzed frames on.

[SENSe][:LTE]:FRAMe:COUNt:STATe <State>

This command turns manual selection of the number of frames you want to analyze on and off.

Parameters:

<State>

ON
You can set the number of frames to analyze.

OFF
The R&S FSQ analyzes a single sweep.

*RST: ON

Example:
```
FRAM:COUN:STAT ON
```
Turns manual setting of number of frames to analyze on.

[SENSe]:SWEep:TIME <CaptLength>

This command sets the capture time.

Parameters:

<CaptLength>

Numeric value in seconds.

Default unit: s

Example:
```
SWE:TIME 40
```
Defines a capture time of 40 seconds.

9.7.1.4 Configuring On/Off Power Measurements

CONFigure[:LTE]:OOPower:NFRames.....121

CONFigure[:LTE]:OOPower:NFRames <Frames>

This command defines the number of frames that are analyzed for On/Off Power measurements.

Parameters:

<Frames>

<numeric value>

Example:
```
CONF:OOP:NFR 10
```
Defines 10 frames to be analyzed.

9.7.1.5 Triggering Measurements

TRIGger[:SEQuence]:HOLDoff<analyzer>....122
TRIGger[:SEQuence]:IFPower:HOLDoff....122
TRIGger[:SEQuence]:IFPower:HYSTeresis....122
TRIGger[:SEQuence]:LEVel<analyzer>:POWer....122
TRIGger[:SEQuence]:MODE....123

TRIGger[:SEQuence]:HOLDoff<analyzer> <Offset>

This command defines the trigger offset.

Parameters:

<Offset> <numeric value>

*RST: 0 s
Default unit: s

Example: `TRIG:HOLD 5MS`
Sets the trigger offset to 5 ms.

TRIGger[:SEQuence]:IFPower:HOLDoff <Offset>

This command defines the holding time before the next trigger event.

Note that this command is available for **any trigger source**, not just IF Power.

Parameters:

<Offset> Range: 150 ns to 10 s
*RST: 150 ns
Default unit: s

Example: `TRIG:IFP:HOLD 1`
Defines a holdoff of 1 second.

TRIGger[:SEQuence]:IFPower:HYSTeresis <Hysteresis>

This command defines the trigger hysteresis.

Parameters:

<Hysteresis> Range: 3 to 50
*RST: 3
Default unit: dB

Example: `TRIG:IFP:HYST 10`
Defines a trigger hysteresis of 10 dB.

TRIGger[:SEQuence]:LEVel<analyzer>:POWer <Level>

This command defines the trigger level for an IF power trigger.

Parameters:

<Level> Default unit: DBM

Example: `TRIG:LEV:POW 10`
Defines a trigger level of 10 dBm.

TRIGger[:SEQuence]:MODE <Source>

This command selects the trigger source.

Parameters:
<Source>
EXTernal
Selects external trigger source.
IFPower
Selects the IF power trigger source.
IMMediate
Selects free run trigger source.
*RST: IMMediate

Example: `TRIG:MODE EXT`
Selects an external trigger source.

9.7.2 Configuring MIMO Setups

CONFigure[:LTE]:DL:MIMO:ASELection....123
CONFigure[:LTE]:DL:MIMO:CONFig....123

CONFigure[:LTE]:DL:MIMO:ASELection <Antenna>

This command selects the antenna for measurements with MIMO setups.

Parameters:
<Antenna>
ANT1 | ANT2 | ANT3 | ANT4
Select a single antenna to be analyzed
*RST: ANT1

Example: `CONF:DL:MIMO:ASEL ANT3`
Selects antenna 3 to be analyzed.

CONFigure[:LTE]:DL:MIMO:CONFig <NofAntennas>

This command sets the number of antennas in the MIMO setup.

Parameters:
<NofAntennas>
TX1
Use one Tx-antenna
TX2
Use two Tx-antennas
TX4
Use four Tx-antennas
*RST: TX1

Example: `CONF:DL:MIMO:CONF TX2`
TX configuration with two antennas is selected.

9.7.3 Advanced General Settings

9.7.3.1 Controlling I/Q Data

[SENSe]:SWAPiq....124

[SENSe]:SWAPiq <State>

This command turns a swap of the I and Q branches on and off.

Parameters:
<State> ON | OFF
*RST: OFF

Example: `SWAP ON`
Turns a swap of the I and Q branches on.

9.7.3.2 Controlling the Input

For information on the remote commands for reference level and attenuation settings see chapter 9.7.1.2, "Configuring the Input Level", on page 117.

INPut:SELect....124
INPut<n>:FILTer:YIG:AUTO....125
INPut<n>:FILTer:YIG[:STATe]....125
TRACe:IQ:FILTer:FLATness....125

INPut:SELect <Source>

This command selects the signal source.

Parameters:
<Source>
RF
Selects the RF input as the signal source.
AIQ
Selects the analog baseband input as the data source. This source is available only with option R&S FSQ-B71.
DIQ
Selects the digital baseband input as the data source. This source is available only with option R&S FSQ-B17.

Example: `INP DIQ`
Selects the digital baseband input.

INPut<n>:FILTer:YIG:AUTO <State>

This command turns automatic control of the YIG filter on and off.

Parameters:

<State> ON | OFF

*RST: ON

Example: `INP:FILT:YIG:AUTO ON`

Activates automatic control of the YIG filter.

INPut<n>:FILTer:YIG[:STATe] <State>

This command removes or adds the YIG filter from the signal path.

If you remove the filter, you can use the maximum bandwidth, but image frequency rejection is no longer ensured.

Parameters:

<State> ON | OFF

*RST: ON

Example: `INP:FILT:YIG OFF`

Removes the YIG filter from the signal path.

TRACe:IQ:FILTer:FLATness <FilterType>

This command turns the wideband filter on and off.

Parameters:

<FilterType> **NORMal**

Uses the normal filter.

WIDE

Turns the wideband filter on.

*RST: NORMal

Example: `TRAC:IQ:FILT:FLAT WIDE`

Turns the wideband filter on.

9.7.3.3 Configuring the Baseband Input

INPut:IQ:BALanced[:STATe] 125
INPut:IQ:IMPedance 126
INPut:IQ:TYPE 126
[SENSe]:IQ:LPASs[:STATe] 126
[SENSe]:IQ:DITHer[:STATe] 126

INPut:IQ:BALanced[:STATe] <State>

This command selects if the I/Q inputs are symmetrical (balanced) or asymmetrical (unbalanced)

This command requires option R&S FSQ-B71.

Parameters:

<State> ON | OFF

*RST: ON

Example: `INP:IQ:BAL ON`

Specifies symmetrical (balanced) IQ inputs.

INPut:IQ:IMPedance <Impedance>

This command selects the input impedance for I/Q inputs.

This command requires option R&S FSQ-B71.

Parameters:

<Impedance> LOW | HIGH

*RST: LOW

Example: `INP:IQ:IMP LOW`

Selects low input impedance for I/Q input.

INPut:IQ:TYPE <Path>

This command selects the input path for baseband input.

Parameters:

<Path> **IQ**

I+j*Q

I

I only

Q

Q only

Example: `INP:IQ:TYPE I`

Uses I input as the baseband path.

[SENSe]:IQ:LPASs[:STATe] <State>

This command turns a baseband input lowpass filter on and off.

Parameters:

<State> ON | OFF

*RST: ON

Example: `IQ:LPAS ON`

Activate the input lowpass.

[SENSe]:IQ:DITHer[:STATe] <State>

This command adds or removes a noise signal into the signal path (dithering).

Parameters:
<State> ON | OFF
*RST: OFF

Example: `IQ:DITH ON`
Activate input dithering.

9.7.3.4 Configuring the Digital I/Q Input

INPut<n>:DIQ:SRATe....127
INPut<n>:DIQ:RANGe[:UPPer]....127

INPut<n>:DIQ:SRATe <SampleRate>

This command defines the sampling rate for a digital I/Q signal source.

Parameters:
<SampleRate> *RST: 10 MHz
Default unit: Hz

Example: `INP:DIQ:SRAT 10MHZ`
Defines a sampling rate of 10 MHz.

INPut<n>:DIQ:RANGe[:UPPer] <ScaleLevel>

This command defines the full scale level for a digital I/Q signal source.

Parameters:
<ScaleLevel> *RST: 1 V
Default unit: V

Example: `INP:DIQ:RANG 0.7`
Sets the full scale level to 0.7 V.

9.7.4 Configuring Downlink Signal Demodulation

9.7.4.1 Configuring the Data Analysis

[SENSe][:LTE]:DL:DEMod:AUTO....128
[SENSe][:LTE]:DL:DEMod:BESTimation....128
[SENSe][:LTE]:DL:DEMod:CBSCrambling....128
[SENSe][:LTE]:DL:DEMod:CESTimation....128
[SENSe][:LTE]:DL:DEMod:EVMCalc....129
[SENSe][:LTE]:DL:DEMod:MCFilter....129
[SENSe][:LTE]:DL:DEMod:PRData....129
[SENSe][:LTE]:DL:FORMat:PSCD....129

[SENSe][:LTE]:DL:DEMod:AUTO <State>

This command turns automatic demodulation for downlink signals on and off.

Parameters:

<State> ON | OFF

*RST: ON

Example: `DL:DEM:AUTO ON`

Activates the auto-demodulation for DL.

[SENSe][:LTE]:DL:DEMod:BESTimation <State>

This command turns boosting estimation for downlink signals on and off.

Parameters:

<State> ON | OFF

*RST: ON

Example: `DL:DEM:BEST ON`

Turns boosting estimation on.

[SENSe][:LTE]:DL:DEMod:CBSCrambling <State>

This command turns scrambling of coded bits for downlink signals on and off.

Parameters:

<State> ON | OFF

*RST: ON

Example: `DL:DEM:CBSC ON`

Activate scrambling of coded bits.

[SENSe][:LTE]:DL:DEMod:CESTimation <Type>

This command selects the channel estimation type for downlink signals.

Parameters:

<Type> **TGPP**

3GPP EVM definition

PIL

Optimal, pilot only

PILP

Optimal, pilot and payload

*RST: TGPP

Example: `DL:DEM:CEST TGPP`

Use 3GPP EVM definition for channel estimation.

[SENSe][:LTE]:DL:DEMod:EVMCalc <Calculation>

This command selects the EVM calculation method for downlink signals.

Parameters:

<Calculation>
TGPP
3GPP definition
OTP
Optimal timing position
*RST: TGPP

Example: `DL:DEM:EVMC TGPP`
Use 3GPP method.

[SENSe][:LTE]:DL:DEMod:MCFilter <State>

This command turns suppression of interfering neighboring carriers on and off (e.g. LTE, WCDMA, GSM etc).

Parameters:

<State>
ON | OFF
*RST: OFF

Example: `DL:DEM:MCF ON`
Turns suppression on of neighboring carriers on.

[SENSe][:LTE]:DL:DEMod:PRData <Reference>

This command the type of reference data to calculate the EVM for the PDSCH.

Parameters:

<Reference>
AUTO
Automatic identification of reference data.
ALL0
Reference data is 0, according to the test model definition.

Example: `DL:DEM:PRD ALL0`
Sets the reference data of the PDSCH to 0.

[SENSe][:LTE]:DL:FORMat:PSCD <Format>

This command selects the method of identifying the PDSCH resource allocation.

Parameters:

<Format>

OFF
Applies the user configuration of the PDSCH subframe regardless of the signal characteristics.

PDCCH
Identifies the configuration according to the data in the PDCCH DCIs.

PHYDET
Manual PDSCH configuration: analysis only if the actual subframe configuration matches the configured one.
Automatic PDSCH configuration: physical detection of the configuration.

*RST: PHYD

Example: `DL:FORM:PSCD OFF`
Applies the user configuration and does not check the received signal

9.7.4.2 Compensating Measurement Errors

[SENSe][:LTE]:DL:TRACking:PHASe....130
[SENSe][:LTE]:DL:TRACking:TIME....130

[SENSe][:LTE]:DL:TRACking:PHASe <Type>

This command selects the phase tracking type for downlink signals.

Parameters:

<Type>

OFF
Deactivate phase tracking

PIL
Pilot only

PILP
Pilot and payload

*RST: OFF

Example: `DL:TRAC:PHAS PILPAY`
Use pilots and payload for phase tracking.

[SENSe][:LTE]:DL:TRACking:TIME <State>

This command turns timing tracking for downlink signals on and off.

Parameters:

<State>

ON | OFF

*RST: OFF

Example: `DL:TRAC:TIME ON`
Activates timing tracking.

9.7.4.3 Configuring MIMO Setups

CONFigure[:LTE]:DL:MIMO:CROSstalk.....131

CONFigure[:LTE]:DL:MIMO:CROSstalk <State>

This command turns MIMO crosstalk compensation on and off.

Parameters:

<State> ON | OFF

*RST: OFF

Example: `CONF:DL:MIMO:CROS ON`

Turns crosstalk compensation on.

9.7.5 Configuring Downlink Frames

9.7.5.1 Configuring TDD Signals

CONFigure[:LTE]:DL:TDD:SPSC.....131
CONFigure[:LTE]:DL:TDD:UDConf.....131

CONFigure[:LTE]:DL:TDD:SPSC <Configuration>

Selects the configuration of a TDD special subframe.

Parameters:

<Configuration> <numeric value>

Numeric value that defines the subframe configuration. Subframe configurations 7 and 8 are only available if the cyclic prefix is normal.

Range: 0 to 8

*RST: 0

Example: `CONF:DL:CYCP NORM`

Selects normal cyclic prefix.

`CONF:DL:TDD:SPSC 7`

Selects subframe configuration 7, available only with a normal cyclic prefix.

CONFigure[:LTE]:DL:TDD:UDConf <Configuration>

This command selects the UL/DL subframe configuration for downlink signals.

Parameters:

<Configuration> Range: 0 to 6

*RST: 0

Example: `CONF:DL:TDD:UDC 2`
Selects allocation configuration number 2.

9.7.5.2 Configuring the Physical Layer Cell Identity

CONFigure[:LTE]:DL:PLC:CID....132
CONFigure[:LTE]:DL:PLC:CIDGroup....132
CONFigure[:LTE]:DL:PLC:PLID....132
FETCh:PLC:CIDGroup?....133
FETCh:PLC:PLID?....133

CONFigure[:LTE]:DL:PLC:CID <CellId>

This command defines the cell ID.

Parameters:
<CellId>
AUTO
Automatically defines the cell ID.
<numeric value>
Number of the cell ID.
Range: 0 to 503

Example: `CONF:DL:PLC:CID 12`
Defines the cell ID 12.

CONFigure[:LTE]:DL:PLC:CIDGroup <GroupNumber>

This command selects the cell ID group for downlink signals.

Parameters:
<GroupNumber>
AUTO
Automatic selection
0...167
Manual selection
*RST: AUTO

Example: `CONF:DL:PLC:CIDG 134`
Cell identity group number 134 is selected
`CONF:DL:PLC:CIDG AUTO`
Automatic cell identity group detection is selected

CONFigure[:LTE]:DL:PLC:PLID <Identity>

This command defines the physical layer cell identity for ownlink signals.

Parameters:

<Identity>

AUTO
Automatic selection

0...2
Manual selection

*RST: AUTO

Example: `CONF:DL:PLC:PLID 1`
Selects physical layer cell ID 2.

FETCh:PLC:CIDGroup?

This command queries the cell identity group that has been detected.

Return values:

<CidGroup>

The command returns -1 if no valid result has been detected yet.

Range: 0 to 167

Example: `FETC:PLC:CIDG?`
Returns the current cell identity group.

Usage: Query only

FETCh:PLC:PLID?

This command queries the cell identity that has been detected.

Return values:

<Identity>

The command returns -1 if no valid result has been detected yet.

Range: 0 to 2

Example: `FETC:PLC:PLID?`
Returns the current cell identity.

Usage: Query only

9.7.5.3 Configuring PDSCH Subframes

CONFigure[:LTE]:DL:CSUBframes....133
CONFigure[:LTE]:DL:SUBFrame<subframe>:ALCount....134
CONFigure[:LTE]:DL:SUBFrame<subframe>:ALLoc<allocation>[:CW<Cwnum>]:MODulation....134
CONFigure[:LTE]:DL:SUBFrame<subframe>:ALLoc<allocation>:POWer....134
CONFigure[:LTE]:DL:SUBFrame<subframe>:ALLoc<allocation>:RBCount....135
CONFigure[:LTE]:DL:SUBFrame<subframe>:ALLoc<allocation>:RBOFfset....135

CONFigure[:LTE]:DL:CSUBframes <NofSubframes>

This command selects the number of configurable subframes in the downlink signal.

Parameters:

<NofSubframes> Range: 0 to 39
*RST: 1

Example: `CONF:DL:CSUB 5`
Sets the number of configurable subframes to 5.

CONFigure[:LTE]:DL:SUBFrame<subframe>:ALCount <NofAllocations>

This command defines the number of allocations in a downlink subframe.

Parameters:

<NofAllocations> <numeric value>
*RST: 1

Example: `CONF:DL:SUBF2:ALC 5`
Defines 5 allocations for subframe 2.

CONFigure[:LTE]:DL:SUBFrame<subframe>:ALLoc<allocation>[:CW<Cwnum>]:MODulation <Modulation>

This command selects the modulation of an allocation in a downlink subframe.

Suffix:

<Cwnum> 1..n
Selects the codeword.

Parameters:

<Modulation> **QPSK**
QPSK modulation

QAM16
16QAM modulation

QAM64
64QAM modulation

*RST: QPSK

Example: `CONF:DL:SUBF2:ALL5:CW2:MOD QAM64`
Selects a 64QAM modulation for the second codeword of allocation 5 in subframe 2.

CONFigure[:LTE]:DL:SUBFrame<subframe>:ALLoc<allocation>:POWer <Power>

This command defines the (relative) power of an allocation in a downlink subframe.

Parameters:

<Power> <numeric value>
*RST: 0 dB
Default unit: DB

Example: `CONF:DL:SUBF2:ALL5:POW -1.3`
Defines a relative power of 1.3 dB for allocation 5 in subframe 2.

CONFigure[:LTE]:DL:SUBFrame<subframe>:ALLoc<allocation>:RBCount <ResourceBlocks>

This command selects the number of resource blocks of an allocation in a downlink subframe.

Parameters:

<ResourceBlocks> <numeric value>

*RST: 6

Example: `CONF:DL:SUBF2:ALL5:RBC 25`

Defines 25 resource block for allocation 5 in subframe 2.

CONFigure[:LTE]:DL:SUBFrame<subframe>:ALLoc<allocation>:RBOFfset <Offset>

This command defines the resource block offset of an allocation in a downlink subframe.

Parameters:

<Offset> <numeric value>

*RST: 0

Example: `CONF:DL:SUBF2:ALL5:RBOF 3`

Defines a resource block offset of 3 for allocation 5 in subframe 2.

9.7.6 Defining Advanced Signal Characteristics

9.7.6.1 Defining the PDSCH Resource Block Symbol Offset

CONFigure[:LTE]:DL:PSOFfset.....135

CONFigure[:LTE]:DL:PSOFfset <Offset>

This command defines the symbol offset for PDSCH allocations relative to the start of the subframe.

The offset applies to all subframes.

Parameters:

<Offset> **AUTO**

Automatically determines the symbol offset.

<numeric value>

Manual selection of the symbol offset.

Range: 0 to 4

*RST: AUTO

Example: `CONF:DL:PSOF 2`

Sets an offset of 2 symbols.

9.7.6.2 Configuring the Reference Signal

CONFigure[:LTE]:DL:REFSig:POWer....136

CONFigure[:LTE]:DL:REFSig:POWer <Power>

This command defines the relative power of the reference signal.

Parameters:

<Power> <numeric value>

*RST: 0 dB
Default unit: DB

Example: `CONF:DL:REFS:POW -1.2`
Sets a relative power of -1.2 dB.

9.7.6.3 Configuring the Synchronization Signal

CONFigure[:LTE]:DL:SYNC:ANTenna....136
CONFigure[:LTE]:DL:SYNC:PPOWer....136
CONFigure[:LTE]:DL:SYNC:SPOWer....136

CONFigure[:LTE]:DL:SYNC:ANTenna <Antenna>

This command selects the antenna that transmits the P-SYNC and the S-SYNC.

Parameters:

<Antenna> ANT1 | ANT2 | ANT3 | ANT4 | ALL | NONE

*RST: ALL

Example: `CONF:DL:SYNC:ANT ALL`
All antennas are used to transmit the P-SYNC and S-SYNC.

CONFigure[:LTE]:DL:SYNC:PPOWer <Power>

This command defines the relative power of the P-SYNC.

Parameters:

<Power> <numeric value>

*RST: 0 dB
Default unit: DB

Example: `CONF:DL:SYNC:PPOW 0.5`
Sets a relative power of 0.5 dB.

CONFigure[:LTE]:DL:SYNC:SPOWer <Power>

This command defines the relative power of the S-SYNC.

Parameters:

<Power> <numeric value>

*RST: 0 dB
Default unit: DB

Example: `CONF:DL:SYNC:SPOW 0.5`
Sets a relative power of 0.5 dB.

9.7.6.4 Configuring the Control Channel

CONFigure[:LTE]:DL:PBCH:POWer....137
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CONFigure[:LTE]:DL:PHICh:NGParameter....139
CONFigure[:LTE]:DL:PHICh:NOGRoups....140
CONFigure[:LTE]:DL:PHICh:POWer....140

CONFigure[:LTE]:DL:PBCH:POWer <Power>

This command defines the relative power of the PBCH.

Parameters:

<Power> <numeric value>

*RST: 0 dB
Default unit: DB

Example: `CONF:DL:PBCH:POW -1.1`
Sets the relative power to -1.1 dB.

CONFigure[:LTE]:DL:PBCH:STAT <State>

This command turns the PBCH on and off.

Parameters:

<State> ON | OFF

*RST: ON

Example: `CONF:DL:PBCH:STAT ON`
Activates the PBCH.

CONFigure[:LTE]:DL:PCFich:POWer <Power>

This command defines the relative power of the PCFICH.

Parameters:
<Power> <numeric value>
*RST: 0 dB
Default unit: DB

Example: `CONF:DL:PCF:POW 0`
Sets the relative power to 0 dB.

CONFigure[:LTE]:DL:PCFich:STAT <State>

This command turns the PCFICH on and off.

Parameters:
<State> ON | OFF
*RST: ON

Example: `CONF:DL:PCF:STAT ON`
Activates the PCFICH.

CONFigure[:LTE]:DL:PDCCh:FORMat <Format>

This command selects the PDCCH format.

Parameters:
<Format> -1 | 0 | 1 | 2 | 3
*RST: -1

Example: `CONF:DL:PDCCH:FORM 0`
Sets the PDDCH format to 0.

CONFigure[:LTE]:DL:PDCCh:NOPD <NofPDCCH>

This command sets the number of PDCCHs.

Parameters:
<NofPDCCH> <numeric value>
*RST: 0

Example: `CONF:DL:PDCCH:NOPD 3`
Sets the number of DPCCHs to 3.

CONFigure[:LTE]:DL:PDCCh:POWer <Power>

This command defines the relative power of the PDCCH.

Parameters:
<Power> <numeric value>
*RST: 0 dB
Default unit: DB

Example: `CONF:DL:PDCCH:POW -1.2`
Sets the relative power to -1.2 dB.

CONFigure[:LTE]:DL:PHICh:DURation <Duration>

This command selects the PHICH duration.

Parameters:

<Duration>
NORM
Normal
EXT
Extended
*RST: NORM

Example: `CONF:DL:PHIC:DUR NORM`
Selects normal PHICH duration.

CONFigure[:LTE]:DL:PHICh:MITM <State>

This command includes or excludes the use of the PHICH special setting for enhanced test models.

Parameters:

<State>
ON | OFF
*RST: OFF

Example: `CONF:DL:PHIC:MITM ON`
Activates PHICH TDD m_i=1 (E-TM)

CONFigure[:LTE]:DL:PHICh:NGParameter <Ng>

This command selects the method that determines the number of PHICH groups in a subframe.

Parameters:

<Ng>
NG1_6 | NG1_2 | NG1 | NG2 | NGCUSTOM
Select NG_CUSTOM to customize N_g. You can then define the variable as you like with `CONFigure[:LTE]:DL:PHICh:NOGRoups`.
*RST: NG1_6

Example: `CONF:DL:PHIC:NGP NG1_6`
Sets N_g to 1/6. The number fo PHICH groups in the subframe depends on the number of resource blocks.
`CONF:DL:PHIC:NGP NG_CUSTOM`
Define a customized value for N_g.
`CONF:DL:PHIC:NOGR 5`
Directly sets the number of PHICH groups in the subframe to 5.

CONFigure[:LTE]:DL:PHICh:NOGRoups <NofGroups>

This command sets the number of PHICH groups.

Parameters:

<NofGroups> <numeric value>

*RST: 0

Example: `CONF:DL:PHIC:NOGR 5`
Sets number of PHICH groups to 5.

CONFigure[:LTE]:DL:PHICh:POWer <Power>

This command defines the relative power of the PHICH.

Parameters:

<Power> <numeric value>

*RST: -3.01 dB
Default unit: DB

Example: `CONF:DL:PHIC:POW -1.3`
Sets the relative power to -1.3 dB.

9.8 Analyzing Measurement Results

9.8.1 General Commands for Result Analysis

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[SENSe][:LTE]:SUBFrame:SELect....141
UNIT:BSTR....141
UNIT:EVM....141

CONFigure[:LTE]:DL:CONS:LOCation <Location>

This command selects the data source of the constellation diagram for measurements on downlink signals.

Parameters:

<Location> **AMD**
After the MIMO decoder

BMD
Before the MIMO decoder

*RST: BMD

Example: `CONF:DL:CONS:LOC AMD`
Use data from after the MIMO decoder.

[SENSe][:LTE]:SUBFrame:SELect <Subframe>

This command selects the subframe to be analyzed.

Parameters:

<Subframe> ALL | <numeric value>

ALL
Select all subframes

0...39
Select a single subframe

*RST: ALL

Example: `SUBF:SEL ALL`
Select all subframes for analysis.

UNIT:BSTR <Unit>

This command selects the way the bit stream is displayed.

Parameters:

<Unit> **SYMbols**
Displays the bit stream using symbols

BITs
Displays the bit stream using bits

*RST: SYMbols

Example: `UNIT:BSTR BIT`
Bit stream gets displayed using Bits.

UNIT:EVM <Unit>

This command selects the EVM unit.

Parameters:

<Unit> **DB**
EVM results returned in dB

PCT
EVM results returned in %

*RST: PCT

Example: `UNIT:EVM PCT`
EVM results to be returned in %.

9.8.2 Using Markers

CALCulate<n>:MARKer<m>:AOFF....142
CALCulate<n>:MARKer<m>[:STATe]....142
CALCulate<n>:MARKer<m>:TRACe....142
CALCulate<n>:MARKer<m>:X....142
CALCulate<n>:MARKer<m>:Y?....143

CALCulate<n>:MARKer<m>:AOFF

This command turns all markers and delta markers off.

Suffix:
<m> 1

Example: `CALC:MARK:AOFF`
Switches off all markers.

Usage: Event

CALCulate<n>:MARKer<m>[:STATe] <State>

This command turns markers on and off.

Suffix:
<m> 1

Parameters:
<State> ON | OFF
*RST: OFF

Example: `CALC:MARK3 ON`
Switches on marker 3 or switches to marker mode.

CALCulate<n>:MARKer<m>:TRACe <Trace>

This command selects the trace the marker is positioned on.

Note that the corresponding trace must have a trace mode other than "Blank".

If necessary, the command activates the marker first.

Suffix:
<m> 1

Parameters:
<Trace> **1 to 6**
Trace number the marker is assigned to.

CALCulate<n>:MARKer<m>:X <Position>

This command moves a marker to a particular coordinate on the x-axis.

If necessary, the command activates the marker.

Suffix:
<m> 1

Parameters:
<Position> Numeric value that defines the marker position on the x-axis.
Default unit: The unit depends on the result display.

Example: `CALC:MARK:X 1GHZ`
Moves the marker to the frequency of 1 GHz.

CALCulate<n>:MARKer<m>:Y?

This command queries the position of a marker on the y-axis.

If necessary, the command activates the marker first.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweeps.

Suffix:
<m> 1

Example: `INIT:CONT OFF`
Switches to single measurement mode.
`CALC:MARK2 ON`
Switches marker 2.
`INIT;*WAI`
Starts a measurement and waits for the end.
`CALC:MARK2:Y?`
Outputs the measured value of marker 2.

Usage: Query only

9.8.3 Scaling the Vertical Diagram Axis

Programming example to scale the y-axis

```
//Start EVM vs Symbol result display in screen B.
CALC2:FEED 'EVM:EVSY'
//Refresh the measurement results based on the contents of the capture buffer
INIT:IMM
//Select screen B.
DISP:WIND2:SEL
//Select dB as the EVM unit.
UNIT:EVM DB
//Define the point of origin of 5 dB on the y-axis.
DISP:TRAC:Y:SCAL:FIXS:OFFS 5
//Define the distance of 10 dB between two grid lines on the y-axis.
DISP:TRAC:Y:SCAL:FIXS:PERD 10
```

DISPlay[:WINDow]:TRACe:Y:SCALe:AUTO.....144
DISPlay[:WINDow]:TRACe:Y:SCALe:FIXScale:OFFSet.....144
DISPlay[:WINDow]:TRACe:Y:SCALe:FIXScale:PERDiv.....144

DISPlay[:WINDow]:TRACe:Y:SCALe:AUTO

This command automatically adjusts the scale of the y-axis to the current measurement results.

Note that the command only affects the result display selected with `DISPlay[:WINDow<n>]:SELect`.

Example: `DISP:TRAC:Y:SCAL:AUTO`
Scales the y-axis of the selected result display.

Usage: Event

DISPlay[:WINDow]:TRACe:Y:SCALe:FIXScale:OFFSet <Origin>

This command defines the point of origin of the y-axis and thus has an effect on the scale of the y-axis.

Note that the command only affects the result display selected with `DISPlay[:WINDow<n>]:SELect`.

Parameters:
<Origin> Point of origin of the y-axis.
The unit depends on the result display you want to scale.

Example: See chapter 9.8, "Analyzing Measurement Results", on page 140.

DISPlay[:WINDow]:TRACe:Y:SCALe:FIXScale:PERDiv <Distance>

This command defines the distance between two grid lines on the y-axis and thus has an effect on the scale of the y-axis.

Note that the command only affects the result display selected with `DISPlay[:WINDow<n>]:SELect`.

Parameters:
<Distance> The unit depends on the result display you want to scale.

Example: See chapter 9.8, "Analyzing Measurement Results", on page 140.

9.9 Configuring the Software

CONFigure:PRESet....145
DISPlay[:WINDow<n>]:SELect....145
FORMat[:DATA]....145
MMEMory:LOAD:DEModsetting....145
MMEMory:LOAD:TMOD:DL....146

CONFigure:PRESet

Initiates a preset to the default state of the software, and, if connected to an analyzer, also presets the analyzer.

Example: `CONF:PRES`
Presets the software.

Usage: Event

DISPlay[:WINDow<n>]:SELect

This command selects the measurement window.

Example: `DISP:WIND2:SEL`
Selects screen B.

Usage: Event

FORMat[:DATA] [<Format>]

This command specifies the data format for the data transmission between the LTE measurement application and the remote client. Supported formats are ASCII or REAL32.

Parameters:
<Format> ASCii | REAL
*RST: ASCii

Example: `FORM REAL`
The software will send binary data in Real32 data format.

MMEMory:LOAD:DEModsetting <Path>

This command restores previously saved demodulation settings.

The file must be of type "*.allocation" and depends on the link direction that was currently selected when the file was saved. You can load only files with correct link directions.

Setting parameters:
<Path> String containing the path and name of the file.

Example: `MMEM:LOAD:DEM 'D:\USER\Settingsfile.allocation'`

Usage: Setting only

MMEMory:LOAD:TMOD:DL <TestModel>

This command loads an EUTRA test model (E-TM).

The test models are in accordance with 3GPP TS 36.141.

Setting parameters:

<TestModel>

'E-TM1_1__10MHz'
EUTRA Test Model 1.1 (E-TM1.1)

'E-TM1_2__10MHz'
EUTRA Test Model 1.2 (E-TM1.2)

'E-TM2__10MHz'
EUTRA Test Model 2 (E-TM2)

'E-TM3_1__10MHz'
EUTRA Test Model 3.1 (E-TM3.1)

'E-TM3_2__10MHz'
EUTRA Test Model 3.2 (E-TM3.2)

'E-TM3_3__10MHz'
EUTRA Test Model 3.3 (E-TM3.3)

Example: `MMEM:LOAD:TMOD:DL 'E-TM2__10MHz'`
Selects test model 2 for a 10 MHz bandwidth.

Usage: Setting only

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